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Introduction

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Scientific and technical reports of the National Aeronautics and Space Administration and its contractors; scientific and technical reports of government agencies, universities, and research organizations throughout the world.

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02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **2586**

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Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **2606**

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Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **2617**

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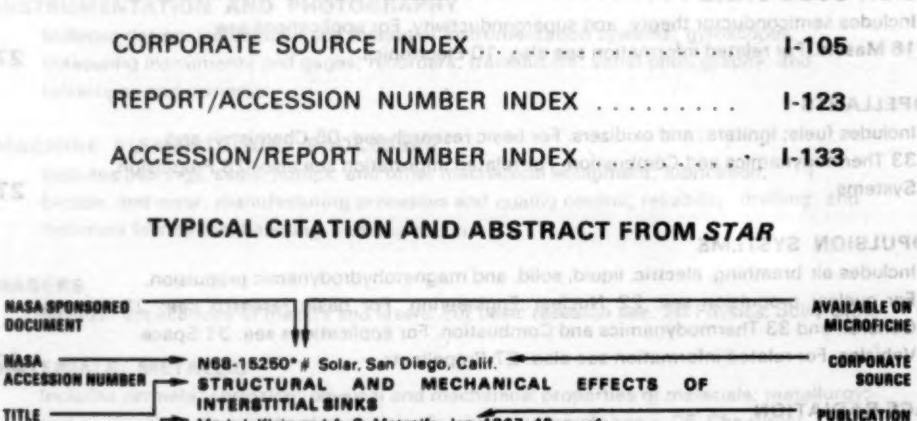

N68-15250*# Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65
CSCL 11F

The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

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01 AERODYNAMICS

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N68-27034# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SURFACE MEASUREMENTS ON SHARP FLAT PLATES AND WEDGES IN LOW-DENSITY HYPERSONIC FLOW

Robert J. Vidal and John A. Bartz Feb. 1968 63 p refs
(Contract AF 49(638)-1433)
(CAL-AF-2041-A-2; AFOSR-68-0645; AD-668552)

Measurements of surface pressure, skin friction, and heat transfer are presented for sharp flat plates at zero angle of attack and at large and small wedge angles in a hypersonic flow. These data largely span the transition from continuum to near-free-molecule flow. The magnitude of slip velocity and energy jump at the surface are inferred from the data. The inferred slip velocity compares favorably with independent measurements by other investigators of slip velocity obtained with pitot probes. The data are compared with relevant theories ranging from the continuum to the free-molecule flow regimes and are used to check the validity of Reynolds analogy. The flat plate data at zero angle of attack are in good agreement with continuum theory when the appropriate Chapman-Rubesin constant is used, and the data are in reasonable agreement with available theories in the viscous layer regime. Heat transfer data are presented which completely define the transition to the free-molecule limit. The data obtained at large wedge angles agree reasonably with viscous shock layer theory which spans the transition from continuum to near-free-molecule flow. Discrepancies appear to be traceable to assumptions in the theory regarding Prandtl number, the Chapman-Rubesin constant, and boundary-layer displacement effects. Data obtained at small wedge angles compare favorably with theory in the continuum limit. Low-density departures of pressure from continuum theory are predicted reasonably by a momentum integral theory. Author (TAB)

N68-27035# Aerospace Research Labs., Wright-Patterson AFB, Ohio. Hypersonic Research Lab.

A NOTE ON THE VARIATION OF THE UNIT REYNOLDS NUMBER ON A FLAT PLATE AS A FUNCTION OF THE ANGLE OF ATTACK Final Report

Karlheinz O. W. Ball Feb. 1968 13 p refs
(ARL-68-0030; AD-669082)

The effect of the variation of local Reynolds number on certain flow characteristics is often of interest. For example, in order to determine the state, i.e., laminar or transitional, of a separated boundary layer on a flat plate-flap model, variation of the separation length with Reynolds number is required. The Reynolds number variation may be obtained by pitching the model. It is shown, from an inviscid standpoint, that the Reynolds number passes through a maximum, as a function of angle of attack, at an angle of attack larger than zero. Author (TAB)

N68-27085# Aeronautical Research Council (Gt. Brit.).

A THEORETICAL EXPLORATION OF THE FLOW ABOUT AN ELECTRIC ARC TRANSVERSE TO AN AIRSTREAM USING POTENTIAL FLOW METHODS

E. G. Broadbent Mar. 1965 27 p refs Supersedes RAE-TR-65056; ARC-26848
(ARC-R&M-3531) CFSTI: HC$3.00/MF$0.65

The arc cross section is supposed to be a region in which heat is supplied to a continuous stream and in which a body force acts. Pressure variations are assumed small so that incompressible potential flow methods can be used to calculate streamlines and thence flow velocities of the compressible gas by a simple transformation. Example calculations are made in which a non-potential slit is used to obtain a positive drag coefficient, and flow diagrams are given. For future work it is suggested that some of the region constituting the arc should be separated from the external stream by an impenetrable boundary since this should enable closer agreement with experiment to be reached. ESRO

N68-27091# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF THE EXPANSION FLOW FIELD OVER A DELTA WING AT HYPERSONIC SPEEDS

Ernest J. Cross, Jr. Feb. 1968 136 p refs
(ARL-68-0027; AD-669081)

An experimental and analytical investigation was carried out to determine the character of the lee side flow field over a slender delta wing with sharp leading edges in a hypersonic free stream. The experiments of the initial phase of a two part experimental program were for the purpose of obtaining qualitative data to identify the dominant features of the flow field. Schlieren, vapor screen and surface oil flow were useful experimental techniques in this application. The surface pressure, surface temperature, and impact pressure were measured at the points of an extensive array in the lee side flow to determine the magnitude and extent of the flow phenomena. Analysis of the experimental results led to a description of the principal features of the flow field. The character of the flow was identified in three regimes by a specific and dominant property of the flow. The principal concern of this research program was for regime number 2 which had the following characteristics. The viscous flow field on the lee side of the wing caused a significant interaction with the inviscid flow which caused an effective change in the wing geometry. The flow expanded to the displacement boundary layer across the wing leading edge, causing a deflection of the velocity vector toward the plane of symmetry (a plane through the central chord and normal to the surface of the wing), which caused the occurrence of a realignment shock imbedded in the inviscid flow. This shock was sufficiently strong to cause the viscous layer to separate. Results of an impact pressure survey indicated that to a good approximation, the flow field was conical. Author (TAB)

N68-27127# Notre Dame Univ., Ind. Dept. of Aero-Space Engineering.

BASIC AERODYNAMICS OF ROCKETS

John D. Nicolaides *In* White Sands Missile Range Preprints of the Conf. on Unguided Rocket Ballistics Meteorology, Addendum Jan. 1968 p 1–27 refs (See N68-27126 16-20)

The two principal problems in modern unguided rockets are identified as catastrophic yaw and magnus instability. Both of these problems are experimentally and theoretically reviewed, and the important aerodynamic stability coefficients are summarized. Author

N68-27128# Notre Dame Univ., Ind. Dept. of Aero-Space Engineering.

A TECHNIQUE FOR EVALUATING THE STABILITY OF MISSILES IN FREE-FLIGHT

Charles W. Ingram and Thomas A. Clare *In* White Sands Missile Range Preprints of the Conf. on Unguided Rocket Ballistics Meteorology, Addendum Jan. 1968 p 29–78 refs Sponsored in part by Raytheon Co. (See N68-27126 16-20)

A technique is presented for analyzing the dynamic behavior of missiles by utilizing the linear and nonlinear aeroballistic theories in conjunction with numerical computations of the six-degree-of-freedom equations of motion. To illustrate the technique a stability analysis of several typical flights of the Apache sounding rocket was conducted. The analysis indicated that analytical solutions, as well as 6-D computations, are required to investigate in detail regions of stability and instability. Also, it was found that analytical solutions must be employed to determine measures necessary for correcting observed instabilities. Author

N68-27129# Notre Dame Univ., Ind. Dept. of Aero-Space Engineering.

USE OF THE WIND TUNNEL FOR DETERMINING AERODYNAMIC STABILITY COEFFICIENTS

R. S. Eikenberry *In* White Sands Missile Range Preprints of the Conf. on Unguided Rocket Ballistics Meteorology, Addendum Jan. 1968 p 79–121 refs (See N68-27126 16-20)

The method of least squares differential corrections as applied to the analysis of dynamic motion data is briefly discussed. Comparatively simple methods of obtaining dynamic motion data in the wind tunnel are described, with examples. Bearing friction effects are also discussed. Author

N68-27388*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THOUGHTS ON PROGRESS IN ROTATING-WING AERODYNAMICS

F. B. Gustafson [1966] 20 p refs Presented at the Symp. on Low-Speed Aerodyn. Probl. Assoc. with Helicopters and V/STOL Aircraft, Buffalo, 22–24 Jun. 1966
(NASA-TM-X-57710) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Problems on the aerodynamics of helicopter-tyes rotors are discussed in terms of increased maneuver capability at cruise speed, cruise efficiency, noise, blade stress, and vibration. The aerodynamic anomalies associated with the question of retreating-blade section characteristics and boundary layer behavior at high angles of attack are mentioned, and it is pointed out that the separated flow is sometimes two-dimensional and at other times is three-dimensional. Analytical studies on blade-motion stability, amplitude, and vibration content are reviewed. In assessing cruise efficiency, blade-section profile losses are identified as a major source of cruise power loss and point to a need for reconsideration of laminar-flow airfoil sections and all-around blade aerodynamic redesign. The effects of changes in planform and twist on the tip-vortex noise and vibration problem are considered. It is suggested that serious thought be given to means for pooling complex computing machine programs for basic ingredients in rotor aeroelastic treatments. M.G.J.

N68-27411*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ON NONLINEAR LONGITUDINAL DYNAMIC STABILITY

Murray Tobak Washington [1966] 25 p refs Presented at the Flight Mech. Panel of AGARD, Cambridge, Engl., 20–23 Sep. 1966
(NASA-TM-X-59120) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Functional analysis is used to derive nonlinear counterparts of the linear stability derivative and superposition integral formulations for the aerodynamic pitching moment. The recurrence in the nonlinear formulation of integral terms accounting for the past is noted and explained on the basis of an energy balance. The results suggest that the equation of motion characteristic of free-oscillation wind-tunnel experiments may be a Liénard equation. A method of extracting the nonlinear elements of the equation from experimental records is shown to have a close connection with the energy relationships existing between free and forced oscillations. Author

N68-27535*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE SIGNIFICANCE OF NONLINEAR DAMPING TRENDS DETERMINED FOR CURRENT AIRCRAFT CONFIGURATIONS

Harleth G. Wiley Washington [1966] 27 p refs Presented at the AGARD Flight Mech. Panel's Specialists' Meeting on Stability and Control, Cambridge, England, 20–23 Sep. 1966
(NASA-TM-X-59114) CFSTI: HC$3.00/MF$0.65 CSCL 01A

The basic features and accuracy of the rigidly forced dynamic-stability technique used in wind tunnels for measuring pitch- and yaw-damping derivatives at subsonic, transonic, and supersonic speeds are reviewed. The ability of the equipment to permit investigations at high angles of attack where separated flow may be present and in regions of large aerodynamic instabilities is discussed. The effects of sting mounting on the measured derivatives are included. Representative results of experimental research performed for several current and proposed aircraft configurations are presented. The effects of angle of attack, wing-sweepback angle, horizontal-tail size and incidence angle, and nacelle placement on damping are discussed. The results of high angle-of-attack damping investigations of a T-tail transport configuration are presented. The significance of pitch-damping levels to stall entry and recovery for a typical T-tail transport airplane, as determined by analytical and simulator studies, is discussed. Author

N68-27537# Royal Aircraft Establishment, Farnborough (England).

INVESTIGATIONS INTO THE INCREASE IN LIFT OF A FLAPPED WING BY SLOT SUCTION [UNTERSUCHUNGEN UEBER DIE AUFTRIEBSERHOEHUNG EINES KLAPPENFLUEGELS DURCH SCHLITZABSAUGUNG]

K. O. Arnold Dec. 1967 58 p refs Transl. into ENGLISH from Z. Flugwiss. (Brunswick, W. Germany), Vol. 15, No. 2, 1967 p 37–56
(RAE-LIB-TRANS-1269)

Systematic measurements are reported for a rectangular flapped wing on which, for the purpose of boundary layer control, air was sucked into the wing by means of a slot in the upper surface of the flap. In order to approximate two-dimensional flow conditions the wing with the slot extending over the entire span was equipped with lateral end-plates of large size. By controlling the boundary layer separation of flow was prevented over the range of the investigated flap angles $\eta_F = 0^\circ$ to 75°. The pressure distribution came close to that of the potential flow theory so that a considerable gain in lift was achieved. Extensive three-component and pressure distribution measurements were carried out at the Reynolds number $Re_\infty = 3.3 \times 10^5$. The development of the two-dimensional turbulent boundary layer downstream of the suction slot was investigated by means of a special test device. Author

N68-27556# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany). Institut fuer Luftstrahlantriebe.

INVESTIGATIONS AT A TWO STAGE AXIAL FLOW COMPRESSOR WITH HIGH FLOW COEFFICIENT [UNTERSUCHUNGEN AN EINEM ZWEISTUFIGEN AXIALVERDICHTER MIT HOHER DURCHFLUBZIFFER]

B. Dittie Aug. 1967 74 p refs In GERMAN; ENGLISH summary
(DLR-FB-68-22) CFSTI: HC$ 3.00/MF$0.65

Investigations were made of a compressor with controllable stator blades. The results showed that it is possible to increase the flow coefficient to higher values than usual without decreasing the efficiency too much. A theoretical approach concerning the efficiency of an axial flow compressor stage with respect to the flow coefficient and to the degree of reaction was made. The compressor blading was designed with a theoretical flow coefficient of $\phi_{th} = 0,7$. At a Mach number of the relative velocity at the tip of the first stage rotor $M_1 = 0,8$ an isentropic efficiency of $\eta = 92\%$ at maximum was reached and at $M_1 = 1,0$ the efficiency was $\eta = 84\%$. Author

N68-27750# Royal Aircraft Establishment, Farnborough (England).

TESTS AT M = 1.82 ON AN ENGINE INSTALLATION WITH BOUNDARY LAYER DIVERTER FOR A SLENDER GOTHIC WING

R. T. Griffiths Aug. 1967 28 p refs
(RAE-TR-67203) CFSTI: HC$3.00/MF$0.65

Tests made at M = 1.82 on an engine installation representing a design in which four engines were mounted side by side in each of two nacelles, one on each half of a slender gothic wing, with the engines partly buried in the wing are reported. The present Report gives comparative results for an installation incorporating a boundary layer diverter; this led to a 2 x 2 square array of engines in each nacelle, with intakes having vertical wedge compression surface. In this case the nacelles were as short as possible and no attempt was made at partial burying in the wing. With the particular design of boundary layer diverter used, and because of the short nacelles, the nacelle drag was high and the intake pressure recovery was lower than expected. There were small predictable effects on lift and pitching moment. Author

N68-27755*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXAMINATION OF AXIAL-FLOW TURBINE BLADE LOADING CHARACTERISTICS USING DIFFUSION PARAMETERS

Warner L. Stewart, Arthur J. Glassman, and Michael R. Vanco Washington 1967 22 p refs Presented at Winter Ann. Meeting of the Am. Soc. of Mechanical Engr., Pittsburgh, 12–16 Nov. 1967
(NASA-TM-X-52307) CFSTI: HC$3.00/MF$0.65 CSCL 01A

This study was undertaken in order to examine the characteristics that limit solidity reductions in axial-flow turbines. Surface diffusion parameters are defined and related to an overall diffusion parameter. An ideal blade-loading model based on two-dimensional incompressible flow is defined so as to include diffusion among the characteristics interrelated with solidity, reaction, turning, and loading coefficient (ratio of actual to ideal loading). Using assumed blade and velocity distribution models, the loading coefficient is evaluated analytically in terms of the velocity diagram and surface diffusion parameters. Loss data from the literature is used to estimate the diffusion levels corresponding to minimum-loss blading. Author

N68-27874# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

THE STABILITY OF A WEDGE-SHAPED AIRFOIL IN A SUPERSONIC FLOW

A. A. Izmailov 15 Feb. 1968 15 p refs Transl. into ENGLISH from Vestn. Mosk. Univ., Ser. Mat. Mekhan. (Moscow), No. 1, 1967 p 103–110
(Contract NOw-62-0604-c)
(TG-230-T544; AD-667998)

The paper considers the problem of stability of a plate in a supersonic flow. The plate has the form of a strip of infinite width in the plane. One edge is rigidly fixed and the other is free. The additional pressure exerted by the supersonic flow is given by A. A. Ilyushins formula. The possibility of applying the small-parameter method for an approximate solution is discussed. The stagnation velocities are found by approximate solution in series and by the Bubnov-Galerkin method. A comparison of the results of the two methods shows a definite advantage of the latter. Author (TAB)

N68-27975# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.

FLOW STUDIES WITH SWEPT COMPRESSOR CASCADES WITH COMPRESSIBLE SUBSONIC FLOW

U. Stark [1967] 67 p refs Transl. into ENGLISH of Deut. Forschungsanstalt fuer Luft- und Raumfahrt Res. Rept.-67-09, Jan. 1967
(K-TRANS-28) CFSTI: HC$3.00/MF$0.65

The results of experimental investigations on swept compressor cascades at high subsonic Mach numbers (M = 0.3 to 0.9) are presented. In order to determine the aerodynamic behavior of swept compressor cascades, measurements of pressure loss coefficients, turning angles and pressure rise coefficients have been carried out with a straight and two swept compressor cascades with sweep angles of 20 deg and 40 deg in a high-speed cascade wind tunnel. These wake measurements at mid-span position show the fundamental influence of the sweep on compressor cascade performance, which consists in a decrease of the turning angles and pressure rise coefficients and in an increase of the critical Mach number. Measurements of blade-surface pressure distributions in several wall-parallel sections show that depending on the sweep angle, ϕ, the effective inlet angles and the blade-surface pressure distribution of these sections are influenced by the tunnel side-walls. Author (NSA)

N68-28220*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

TRANSITION AND FLOW REATTACHMENT BEHIND AN APOLLO-LIKE BODY AT MACH NUMBERS TO 9

Robert L. Kruse Washington Jul. 1968 31 p refs
(NASA-TN-D-4645) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Transition from laminar to turbulent flow in the near wake of a bluff body has been studied in the Ames Pressurized Ballistic

Range. The location of transition and the reattachment of the separated flow have been determined from shadowgraphs and have been correlated on the basis of Mach number, Reynolds number, and angle of attack. The Mach numbers ranged from 1 to 9, the Reynolds numbers (based on body diameter) from 0.25×10^6, to 5×10^6, and the angles of attack from 0° to 25°. Author

N68-28268*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN INVESTIGATION OF FULL-SCALE HELICOPTER ROTORS AT HIGH ADVANCE RATIOS AND ADVANCING TIP MACH NUMBERS

John L. McCloud III, James C. Biggers, and Robert H. Stroub
Washington Jul. 1968 135 p
(NASA-TN-D-4632) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Five full-scale rotors were investigated at various advance ratios and advancing tip Mach numbers in the Ames 40- by 80-foot wind tunnel. The primary differences between rotors were twist, articulation, and tip airfoil section. Four of the rotors incorporated the NACA 0012 airfoil section over the entire blade length. The fifty rotor had tapering thickness and incorporated leading-edge camber over the outer 20% of the blade radius. The fully articulated rotor with zero twist blades was tested at advance ratios from 0.30 to 1.05. The other rotors were investigated in the 0.30 to 0.50 advance-ratio range. The teetering rotor with tapered tip blades was tested at advancing blade tip Mach numbers up to 1.00. Force, moment, power, and control-setting data were obtained for a wide range of lift and propulsive forces, and are presented without discussion. Author

N68-28271*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

STATIC AERODYNAMIC CHARACTERISTICS OF THREE BLUNTED SIXTY-DEGREE HALF-ANGLE CONES AT MACH NUMBERS FROM 0.60 TO 1.30

Wayne J. Marko 1 Jul. 1968 15 p refs
(Contract NAS7-100)
(NASA-CR-95373; TR-32-1298) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Static aerodynamic characteristics data, obtained during tests in the NASA Ames Research Center 2×2-ft transonic wind tunnel, are compared with JPL data at low supersonic speeds ($M = 2.2$). Base pressures are compared with other JPL data for similar configurations and experimental base pressure data from Sighard F. Horner's *Fluid-Dynamic Drag*. The ranges of model parameters are: nose bluntness (nose radius/base diameter) ratio of 0.10, and edge radius/base diameter ratios of 0.0, 0.05, and 0.10. The best Mach number range was 0.60–1.30. Author

N68-28316 Rensselaer Polytechnic Inst., Troy, N. Y.

FREE BOUNDARY FLOWS OF VISCOUS LIQUID AROUND A ROTATING CONE

Yu Kao Hsu (Ph.D. Thesis) 1966 102 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9284

The present study represents a generalization of a previously studied problem of the laminar flow induced in a Newtonian liquid by rotating cone. In the latter investigation the rotating cone was considered to be closely fitted into a cylindrical container which held the liquid. In such a case, there is no free surface. Since then basic experimental information has been obtained about the nature of the flow lines for the case in which the radius of the container is larger than that for the top of the conical rotor. In fact the flow has been studied for several ratios, β, of the radius of the container in the radius of the top of the rotor. For the special case previously studied β was unity. Using flow visualization techniques and flow timing devices, velocity functions which very precisely define the actual flow were developed. The functions are such that the center line of the Vortical Motion and the flow about it are accurately described. Dissert. Abstr.

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N68-26963# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE DEVELOPMENT OF MODERN BOMBERS

Chien Kong 30 Jun. 1967 11 p Transl. into ENGLISH from Hang K'ung Chih Shih (Chinese People's Rep.), v. 2, no. 6, 1965 p 8–10
(FTD-HT-67-168; AD-668101)

A brief general description is given of bombers. Three kinds of bombers are noted: (1) The heavy or long-range strategic bomber, loaded weight 100 - 200 tons, maximum flying range 7000 km, weapon carrying capacity over 10 tons including atomic bombs and missiles, which is chiefly used for attacking military bases, political, economic, and strategic points. (2) The medium-range strategic bomber, loaded weight 40 - 90 tons, maximum flying range 6000 - 6500 km, weapon carrying capacity over 5 tons, also including atomic bombs and missiles, which is most commonly used for attacking strategic points. (3) The lightweight or tactical bomber, loaded weight 15 - 30 tons, maximum flying range about 3000 km, weapon carrying capacity 3 - 4 tons including small atomic bombs, which is used in the front lines, and for attacking the supply lines and military personnel. It is noted that, under the present conditions, when radar and missiles are used widely in air defense, the trend of bomber development is both toward higher altitudes and greater speed, and lower altitudes and greater speed. TAB

N68-26978# Kaysam Corp. of America, Patterson, N. J.

DEVELOPMENT OF A BALLOON TO REACH 60,000 FEET AT 2,000 FEET PER MINUTE Final Report, 1 Dec. 1966–31 Oct. 1967

Eric Nelson Dec. 1967 45 p
(Contract F19628-67-C-0149)
(AFCRL-68-0087; AD-668542)

A theoretical study was made based on previous experience with ML-399, ML-541 and ML-566 balloons, for the design of a balloon to reach 60,000 feet at 2,000 feet per minute by day and by night. The compounds available were reviewed and two were selected, one suitable for the high modulus gas carrying balloon and the other for the streamlined tail, if this proved necessary. Thick-walled balloons were manufactured from the compound selected and single cell spherical and elliptical balloons were evaluated in flight. As a result of the performance obtained, subsequent flights were restricted to streamlined balloons. Spherical head and elliptical head assemblies with streamlined tails were fabricated and flown. The desired wall thickness was always obtained by placing one or two balloons inside another balloon. An assembly using an intermediate balloon with excellent shape characteristics but low bursting altitude was also evaluated. A double spherical head balloon with a streamlined tail was adopted as the final design. Author (TAB)

N68-27066# Federal Aviation Administration, Washington, D. C. Economics Div.

AVIATION FORECASTS FISCAL YEARS 1968–1979

Jan. 1968 44 p
(AD-668835)

Contents: Highlights of Fiscal Year 1967; Aviation industry forecasts--air carrier traffic, air carrier fleet, general aviation flying and aircraft fleet, domestic aviation fuel consumption, civil aircraft and engine production; FAA air traffic activity forecasts--aircraft operations at airports with FAA traffic control service, FAA en route traffic activity, FAA flight services. TAB

N68-27090# National Aeronautical Establishment, Ottawa (Ontario).

LOW ALTITUDE FLIGHT LOAD SPECTRA FOR LIGHT AIRCRAFT

R. T. Sewell Dec. 1967 38 p refs Submitted for publication
(NAE-LR-495; NRC-10002; AD-668941)

An analysis is presented of more than 1,300 hours flight loads records obtained from light aircraft engaged in low altitude terrain-following operations. It is shown that continuous operation in the average low altitude environment reduces the estimated fatigue life by a factor of 15 to 1 when compared with the normal operating environment, and in the limiting condition imposed by pilot tolerance this factor is increased to 90 to 1. Author (TAB)

N68-27134# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ICING OF AIRCRAFT AND THE MEANS OF PREVENTING IT

O. K. Trunov 29 Aug. 1967 241 p refs Transl. into ENGLISH of the book "Obledeneniye Samoletov i Sredstva Bor'by s Nim" Moscow, Izd. Mashinostr., 1965 p 1–247
(FTD-MT-65-490; AD-668521)

The book acquaints the reader with the physical and theoretical bases of process of icing, the meteorological conditions provoking this phenomenon in flight, and the contemporary thermal and chemical means of the struggle with icing (deicing systems) used on passenger aircraft and helicopters. Also examined in the book are methods of the selection of basic parameters and calculation of the deicing electrical and air-thermal systems, the influence of the degree and form of icing on flying characteristics of the aircraft and the technique of its piloting, and methods of testing aircraft in flight in conditions of icing and peculiarities of icing when the aircraft are on land. Author (TAB)

N68-27138# LTV Aerospace Corp., Dallas, Tex. Vought Aeronautics Div.

RESEARCH ON VTOL WATER HOVER EFFECTS, INCLUDING THE EFFECTS OF WIND AND WAVES Final Report

Keith R. Marsh Apr. 1968 241 p refs
(Contract N00014-67-C-0488)
(Rept.-2-55400/8R-6140; AD-668714)

Very little is known about the problems associated with a VTOL aircraft hovering over a water surface. Some of the more important of these unknown effects appear to be the effects of surface winds and waves on the stability and control characteristics of the hovering airplane, the effects of the airplanes downwash on the water surface, and the effects of surface winds and waves on the spray generated by the airplanes downwash. In order to examine these seemingly more important effects, a special model testing facility has been built. This facility permits a model simulating a hovering airplane to be tested as the facility generates waves of variable heights and lengths on the water surface below the model test station. The facility can also generate a surface wind. During this test a model of a tilting VTOL airplane with four propellers was tested as it simulated hover at varying heights and disk loadings above the variable water surface conditions. The effects of water waves on the forces and moments felt by the hovering model were found to be negligible, and the effects of the surface wind on the forces and moments were found to be as would be predicted with a negligible effect of waves even with the surface wind. By contrast, it was found that the waves and the surface wind both had significant effects on the effects of the airplanes downwash on the water surface and the spray generated around the model. Comparison of some of the spray patterns found in this test program with results of full scale airplane tests indicate that these results of the model tests correlate well with the limited data available from the actual airplane tests. Author (TAB)

N68-27232# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

EXPERIMENTAL COLD-FLOW INVESTIGATION OF CHORDWISE STATIC PRESSURE DISTRIBUTION AROUND A TURBINE AIRFOIL Technical Report, 1 Apr.–1 Jul. 1967

David H. Quick, Robert E. Henderson, and Wayne A. Tall Mar. 1968 65 p refs
(AFAPL-TR-67-147; AD-668766)

The results from preliminary cold-flow tests are presented. The performance of the in-house turbine cascade rig was checked and calibrated over a cascade airflow range of 3 to 7 pounds per second. Cold-flow measurements were made to investigate the chordwise static pressure distribution around the test blade surface. Experimental data from these tests provided valuable velocity, pressure, and flow distributions around the test blade. Once the flow field around the 'standard' blade profile is known, the gas-to-blade heat transfer coefficients around the blade can more accurately be determined. This information is important in assessing the blade cooling design requirements for future hot-flow tests. Author (TAB)

N68-27391*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EVALUATION OF TWO INSTRUMENT-LANDING DISPLAYS IN SIMULATED IFR APPROACHES WITH A HELICOPTER

William Gracey 1967 12 p refs Presented at the 23d Ann. Natl. Forum of the Am. Helicopter Soc., Washington, D. C., 10–12 May 1967
(NASA-TM-X-59866) CFSTI: HC$3.00/MF$0.65 CSCL 01C

Two instrument displays that differed principally in the manner in which course guidance was presented have been evaluated in landing approaches with a helicopter. In one display, course guidance information was presented as a flight-director command on a conventional cross-pointer indicator; in the other display, the information was presented on a moving-map indicator. The tests of the two displays were conducted under simulated IFR conditions along a 6° glide slope at approach airspeeds of about 30 knots. The approaches were carried to a 50-foot breakout and a visual slowdown to hover. The results of the tests are presented in terms of (1) flight performance (i.e., tracking along slope and course), and (2) pilot evaluation of the display concepts. The implications of the results to the design of improved displays are discussed. Author

N68-27430*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ASSESSMENT OF REPEATED LOADS ON GENERAL AVIATION AND TRANSPORT AIRCRAFT

Philip Donely, Joseph W. Jewel, Jr., and Paul A. Hunter [1967] 58 p refs Presented at the 5th Intern. Comm. on Aircraft Fatigue Symp., Melbourne, 22–24 May 1967
(NASA-TM-X-60385) CFSTI: HC$3.00/MF$0.65 CSCL 01C

An assessment is made of recent repeated loads data from short-haul jet transports and several general aviation airplanes. The jet transport data indicate that except for check flight maneuvers the load histories are essentially independent of operator and airplane type. General aviation data show a large amount of scatter in the repeated load history. The use and geographical location of operations may be the primary means of specifying the repeated loads environment. Author

N68-27435# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMICS OF V/STOL AIRCRAFT POWERED BY LIFT FANS

David H. Hickey and Woodrow L. Cook [1967] 20 p refs Presented at the Flight Mech. Panel of Advisory Group for Aeron. Res. and Develop., Goettingen, W. Germany, 11–13 Sep. 1967
(NASA-TM-X-60455) CFSTI: HC$3.00/MF$0.65 CSCL 01C

Data from investigations in the Ames Research Center's 40- by 80-foot wind tunnel of large-scale V/STOL models powered with lift fans are analyzed for parameters affecting induced lift, drag, and pitching moment. While these effects can sometimes be accurately calculated for fan-in-wing installations, a better understanding of the limitations of the calculations is required to allow confident predictions. It is shown that the downwash from lifting fans or engines mounted upstream of a wing unloads the wing during transition. Lift-fan powered VTOL aircraft are shown to have significant overload STOL capability if a gas power transfer control system is used, but with a separate control system the overload capability may be small. Boundary-layer control can provide good inlet performance for very thin fan installations that have small inlet radii. Author

N68-27445*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

V/STOL TERMINAL AREA INSTRUMENT FLIGHT RESEARCH

John P. Reeder [1967] 37 p refs Presented at the Air Transport Session of the 11th Ann. Meeting of the Soc. of Exptl. Test Pilots, Beverly Hills, Calif., 28–30 Sep. 1967
(NASA-TM-X-60456) CFSTI: HC$3.00/MF$0.65 CSCL 01C

An overview is presented on the state-of-the-art in V/STOL instrument flight to illustrate the handling and operation problems encountered at low speeds on an approach guidance system, and the added piloting tasks required in transition flight. Three facets of a research program for generating solutions to these problems are discussed: (1) Handling qualities studies are conducted with a tandem helicopter operated as a variable stability and control airborne simulator; the model-following technique with analog computers is used. (2) Pilot information and flight displays are assessed from the viewpoint that the pilot should remain in the control loop as an active participant. A helicopter is used in the work on improving displays, with the goal being to reduce approach time to 1-1/2 to 2 minutes. (3) For terminal area operations, attention is centered on determining flight controls requirements for critical flight tasks; piloting problems of managing and operating the propulsion and conversion systems while performing the required flight tasks; and determining operating procedures that minimize pilot workload, time, and airspace. M.G.J.

N68-27447*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STRUCTURAL PROSPECTS FOR HYPERSONIC AIR VEHICLES

R. R. Heldenfels [1966] 46 p refs Presented at the 5th Congr. of the Intern. Council of the Aeron. Sci. (ICAS), London, 12–16 Sep. 1966
(NASA-TM-X-59063) CFSTI: HC$3.00/MF$0.65 CSCL 01C

Proposed missions, configurations, and design requirements of hypersonic air vehicles with air-breathing propulsion are reviewed to determine the important structural design problems. High external surface temperatures and internal storage of cryogenic fuel in a vehicle with a structural weight fraction comparable to current subsonic aircraft put stringent requirements on the selection of materials and structural configurations. Structural configurations resulting from research on fuselage liquid hydrogen tankage, wings, heat shields, and air inlets are reviewed to indicate their applicability to a future hypersonic commercial air transport. It is concluded that substantial improvements in materials, structural concepts, and structural analysis are needed if hypersonic transportation is to become routine. A particularly important need is the fabrication of representative structural components for tests under appropriate environmental conditions to determine the adequacy of newly developed structures technology for hypersonic flight applications. Author

N68-27472*# National Aeronautics and Space Administration, Washington, D. C.

APPLICATION OF TECHNOLOGY TO THE FLIGHT MECHANICS OF AIRCRAFT DEVELOPMENT Survey Paper

Lawrence P. Greene (N. Am. Aviation, Inc.), Clem C. Weissman (Navy Dept.), and Jack D. Brewer [1967] 33 p refs Presented at the Joint Meeting of the Fluid Dyn. and Flight Mech. Panels of AGARD, Goettingen, W. Ger., 13 Sep. 1967
(NASA-TM-X-60506) CFSTI: HC$3.00/MF$0.65 CSCL 01C

A general outline of the areas of technical interest to the AGARD Flight Mechanics Panel and the relationship of those technological areas to the overall problems of aircraft development was presented. Specific examples were presented of the technologies applicable to aircraft in conventional modes of flight, as well as VTOL modes. The relationship of technologies of vehicles are illustrated with identification of critical problem areas and technological gaps, and by examples of the impact of certain known characteristics on the overall vehicle configuration. Emphasis is placed on the relationship of propulsion systems integration into the total vehicle development. Author

N68-27550*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

OPERATIONAL ASPECTS OF STEEP VTOL APPROACHES AS DETERMINED FROM HELICOPTER TESTS UNDER SIMULATED IFR CONDITIONS

William Gracey [1967] 20 p refs Presented at the RTCA 1967 Ann. Assembly Meeting, Washington, D. C., 19–20 Sep. 1967
(NASA-TM-X-60457) CFSTI: HC$3.00/MF$0.65 CSCL 01C

The operational factors pertaining to steep VTOL approaches under Instrument Flight Rules (IFR) conditions are discussed. The factors that determine the structure of the landing approach corridor include glide slope angle, path widths, approach length, breakout height, and location of landing pad with respect to slope origin. With a selected approach structure, operational data determined in tests of two experimental instrument displays under simulated IFR conditions are presented. The data include tracking performance, breakout precision, stopping distance, and overall time for the approach. Author

N68-27567# Bunker-Ramo Corp., Canoga Park, Calif.

PILOT FAILURE DETECTION PERFORMANCE WITH THREE LEVELS OF FAULT WARNING INFORMATION, PHASE 1 Final Report, 20 Mar.–28 Apr. 1967

D. Vreuls, S. F. Barnebey, D. E. Nichols, and P. L. Dent Feb. 1968 122 p refs
(Contract FA-67-WA-1700)
(SRDS-RD-68-9)

The first of a series of four studies to examine the feasibility of display and control concepts for commercial subsonic jet transport all-weather (Category III) approach and landing was reported. The study was addressed primarily to fault warning. Pilot detection of autopilot and display system failures was examined with three levels of fault warning display information. Display failure detection and pilot decisions were additionally examined as a function of pilot task load, manual in one axis or automatic. A total of 702 simulated ILS approaches were flown by 18 commercial airline pilots in a Boeing 707-720B research simulator. Pilot/system performance and preference data indicated that the full annunciator display system tested was required in order to attain the best display failure and passive autopilot control failure detection. The failure warning utility of mode progress information below 200 feet of altitude on the approach was found to be inadequate. Author

N68-27695*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA RESEARCH ON STEEPENED APPROACHES FOR NOISE ALLEVIATION

Philip Donely, John A. Zalovcik, and William T. Schaefer, Jr. Washington [1966] 44 p refs Presented at the United Kingdom Intern. Conf. on the Reduction of Noise and Disturbance Caused by Civil Aircraft, London, 22–30 Nov. 1966

(NASA-TM-X-59217) CFSTI: HC$3.00/MF$0.65 CSCL 01C

As part of the national effort to achieve noise reduction, NASA is conducting a study of the operating problems associated with the steepened approach path. To date, approach profile geometry, airplane type, navigational aids and pilot augmentation have been explored. Considerable progress has been made in resolving the elements of a safe steep approach profile. Tests and analysis have indicated that a 6°-approach profile should be feasible. Findings also indicate: (1) The prime source of noise reduction is the power cutback to fly the steepened glide path and amounts to about 13dB in sound pressure level. (2) Pilot activity for glide path control can make a spread in noise level of 8dB for a nominal 6° approach. (3) Improved flight path control is required if steep approaches are to be made to low minimums of ceiling and visibility and to achieve reduced scatter about the lower noise level. (4) Improved engine response time would be a significant factor in assuring a safe steep approach. (5) Improved displays to guide the pilot through transition and flare will be needed. Author

N68-27776# California Univ., Berkeley. Hydraulic Engineering Lab.

RESEARCH ON ANNULAR NOZZLE TYPE GROUND EFFECT MACHINE OPERATING OVER WATER. ANNULAR DISTRIBUTION OF JET MOMENTUM

J. D. Cumming Mar. 1968 27 p *Its* I.E.R. Ser. 187, Issue 8

(Contract Nonr-222(71))

(AD-668695)

The pressure distribution of the jet around the periphery of the annular nozzle of the GEM was measured for various model speeds, clearance heights and air flow rates, and the drag force calculated. It was found that the drag force, although similar to the Havelock solution, was significantly different in two respects. The maximum drag occurred at a lower speed than predicted by the theory, and was approximately proportional to the average base pressure rather than to the square of the base pressure, within the range of variables tested. It was concluded that the wave-making resistance may be transmitted in part to the base by a non-uniform distribution of the jet momentum around the periphery. Author (TAB)

N68-27792*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

FLIGHT RESULTS OBTAINED WITH A NON-AERODYNAMIC, VARIABLE STABILITY, FLYING PLATFORM

Donald L. Mallick, Emil E. Kluever, and Gene J. Matranga [1967] 49 p refs Presented at SETP 10th Symp. and Banquet, Los Angeles, 23 Sep. 1966

(NASA-TM-X-59039) CFSTI: HC$3.00/MF$0.65 CSCL 01C

The research and operational results obtained from 200 flights performed with lunar landing research vehicles are summarized. The single-place free-flying platforms, fabricated of light-weight, tubular, truss structure, were used to examine the problems attendant to lunar landing. Results of the vehicle control system are discussed in relation to system mechanization, rate command evaluation, attitude command evaluation, and reliability. Consideration is also given to cockpit features, operational factors, vertical jet engines, and the ejection seat. Results showed that in rate command, satisfactory control can be achieved with far less on-off control acceleration than could be achieved with proportional acceleration. The accuracy, repeatability, and reliability of the electronics control systems was highly satisfactory. Results also indicated that in simulation, significantly larger angles and considerable lead is required to start and stop translations. B.S.D.

N68-27806*# National Aeronautics and Space Administration, Washington, D. C.

NASA RESEARCH ON PROMISING V/STOL AIRCRAFT CONCEPTS

Jack D. Brewer [1966] 60 p Presented at the 2nd Intern. Congr. on Air Tech., Hot Springs, Ark., 28 Oct. 1968

(NASA-TM-X-59964) CFSTI: HC$3.00/MF$0.65 CSCL 01C

Design concepts, contractor studies, and operational requirements are reviewed in relation to the NASA research program on Vertical and Short Takeoff and Landing (V/STOL) aircraft. The different aircraft concepts that were investigated for achieving a V/STOL capability are noted, and relative merits of some as well as costs are discussed. Studies made indicate the need for advanced systems at the terminal area for aircraft guidance to improve control and safety and to reduce time of instrument-flight conditions. The NASA program for V/STOL study includes the short takeoff and landing short-haul transport, the vertical takeoff and landing transport, the advanced helicopter, and the VTOL tactical fighter. Mention is made of wind tunnel tests that have used a rotating cylinder flap and an augmentor wing to achieve greater lift; and zero visibility landing operational capability as well as noise are discussed. M.W.R.

N68-27871# Sud-Aviation, Paris (France).

DESIGN PHILOSOPHY AND FATIGUE TESTING OF THE CONCORDE

V. P. Nguyen and E. L. Ripley (Roy. Aircraft Estab.) [1967] 31 p Presented at the 5th ICAF Symp., Melbourne, 22–24 May 1967

The Concorde is a civil transport aircraft designed and manufactured jointly by SUD AVIATION and the BRITISH AIRCRAFT CORPORATION. The design has involved the following problems: (1) structure weight which is very important for a supersonic long range aircraft, (2) problems due to the elevated temperatures and (3) problems of designing a structure which is both safe-life and fail safe. SUD AVIATION and BAC have had to make many design studies and many tests in order to reach the present solution. This paper gives general considerations of design and basic material, and wing and fuselage structure. Author

N68-27909# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.

THE APPLICATION OF TI-6AL-4V TITANIUM TO HELICOPTER FATIGUE COMPONENTS

Harry T. Jensen [1966] 28 p refs

The performance of the H-53 helicopter is considerably enhanced as a result of the weight saved by the use of titanium. Since one of the purposes of the paper is to motivate those in the helicopter industry who are not using titanium to consider its use, some of the fundamental information presented may appear academic to you who have been using the material. Yet all of us must recognize that the helicopter requirement is different from other requirements, and attention to fundamentals is necessary. Emphasis in this paper is given to the design and qualification of titanium alloy components whose strength is determined by high cycle low stress fatigue in a normal temperature environment. The pertinent properties of titanium alloys for this requirement are considered in the design of components. In the past these components have been designed and fabricated from 4340 steel. The cost effectiveness of using titanium alloy Ti-6Al-4V in lieu of 4340 steel (150 kpsi F_{tu}) is discussed. The result of comparative fatigue tests of 4340 steel and Ti-6A1-4V components and the testing of 101 Ti-6A1-4V components are the principal data that verify the decision to use Ti-6A1-4V instead of 4340 steel. Test procedures and results are given. Author

N68-27910 Industrie Aeronautiche e Meccaniche, Savona (Italy).

DESIGN AND CERTIFICATION FOR EXECUTIVE TYPE AIRCRAFT

Domenico Lalli and Gennaro Sergio [1967] 65 p Presented at the 5th ICAF Symp., Melbourne, 22–24 May 1967

The paper presents the procedure in designing the model PD-808 Executive Jet Aircraft and in checking its fail-safe philosophy. The first part relates a brief account of the structural components which have been designed to be fail-safe. Of particular interest is the fuselage which, following a new concept, has been designed with large bays and with a corrugated skin inserted between the frames. The second part deals with the analytical methods employed in checking fail-safe strength of the airplane. Much emphasis is given to SIGMA Program which has been prepared to investigate built-up structures following the stiffness method. The third part gives an account of the tests performed for fail-safe purposes. Author

N68-27946# Monsanto Research Corp., Dayton, Ohio.

EXPANDABLE WING TANKS FOR AIRCRAFT

I. O. Salyer, J. L. Schwendeman, C. J. North, A. Zappanti (AF Aero Propulsion Lab.), A. Olevitch (AF Mater. Lab.) et al *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 589–629 (See N68-27917 16-32)

A new concept for making expandable, self-rigidizable structures using the phenomenon of thermoelasticity was developed and used to demonstrate the feasibility of this thermoelastic system in the production of aircraft prototype wing tanks. The process makes use of the reversible change of state from a rigid glass to a rubber which occurs when amorphous, lightly cross-linked, thermosetting polymers are heated to above their second order transition and subsequently cooled to below it. Resins evaluated for the expandable wing prototype were classified into the following two broad general categories: thermoplastic and thermosetting. Thermoplastic resins were limited largely to plasticized cellulose esters, polystyrene, and polyvinyl chloride. Thermosets consisted principally of phenol formaldehyde, urea formaldehyde, and melamines. Studies focusing on the selection of a suitable reinforcing substrate for building a prototype wing tank were concentrated almost entirely on various types, weights, and weaves of glass cloth. Inherent problems associated with developing a folding thermoelastic wing tank as high glass modulus (or of the fiber itself) and wing tank geometry, were also studied. Fabrication techniques used in the development of subscale model tanks are discussed. These studies demonstrated that a reversible, flexible, self-rigidizable, quarter scale wing tank prototype could be made from lightly crosslinked thermoelastomers. A follow-on program to design, construct, and deliver two full size wing tanks for the F-5A and F-5B aircraft is scheduled. S.C.W.

N68-28020*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.

NOISE REDUCTION IN AREAS OF TU-124 AIRCRAFT TAKEOFF [SNIZHENIYE SHUMA NA MESTNOSTI PRI VZLETE SAMOLETA TU-124]

B. N. Mel'nikov NASA May 1968 6 p refs Transl. into ENGLISH from the book "Samoletostroyeniye i Tekhn. Vozdush Flota" Kharkov, Kharkov State Univ. Press, 1966 p 157–161
(Contract NASw-1693)
(NASA-TT-F-11557) CFSTI: HC$3.00/MF$0.65 CSCL 01B

Suggestions for noise reduction in residential areas close to landing strips used by Tu-124 aircraft are presented. The results of acoustic studies determining Tu-124 takeoff trajectories are discussed. Theoretical considerations and technical directions are given for noise-reducing piloting techniques. A family of reduced-noise takeoff and landing trajectories is defined as a function of the aircraft weight, engine power and flap rotation angle. This piloting technique ensures acceptable daytime and nighttime noise levels at distances of 4 and 7.5 km., respectively, from the starting point of the takeoff run. Author

N68-28153*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STUDY OF THE OPTIMUM VALUES OF SEVERAL PARAMETERS AFFECTING LONGITUDINAL HANDLING QUALITIES OF VTOL AIRCRAFT

James R. Kelly and John F. Garren, Jr. Washington Jul. 1968 11 p refs
(NASA-TN-D-4624) CFSTI: HC$3.00/MF$0.65 CSCL 01D

Because of the many factors which influence handling qualities, a disparity often exists between the absolute pilot rating results obtained from various investigations. In this paper, longitudinal handling qualities data from three published studies have been analyzed and compared in terms of pilot rating trends associated with changes in each of several important parameters. Optimum values or points of diminishing returns for each of these parameters (pitch-rate damping, angle-of-attack stability, speed stability, and longitudinal control sensitivity) appear to be largely independent of changes in other parameters and operating conditions covered. Author

N68-28178 Royal Aircraft Establishment, Farnborough (England).

CIVIL AIRCRAFT AIRWORTHINESS DATA RECORDING PROGRAMME—SPECIAL EVENTS RELATING TO AUTOPILOT INDUCED CONTROL DISTURBANCES (MAY 1963 TO DEC. 1965)

Jul. 1967 37 p refs
(RAE-TR-67157) CFSTI: $3.00

Continuous trace records of airworthiness data have been taken from a small number of civil jet aircraft in normal airline service since October 1962. Throughout the recording period the records have been searched for unusual occurrences, and each one has been studied to determine its nature, and where possible, its cause. This report describes a selection of events obtained from three types of aircraft during the period May 1963 to December 1965: the events are grouped into pitch oscillations, autopilot disengagement, and aileron control oscillations. Author

N68-28233*# Northrop Corp., Hawthorne, Calif.

FULL-SCALE GROUND PROXIMITY INVESTIGATION OF A VTOL FIGHTER MODEL AIRCRAFT

Rahim Lavi, Gordon R. Hall, Wilbur W. Stark Washington NASA Jun. 1968 174 p refs
(Contract NAS2-4287)
(NASA-CR-1098; NOR-67-221) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An experimental investigation was conducted to determine the exhaust gas ingestion characteristics and induced aerodynamics for a large-scale VTOL lift engine fighter model operating in ground proximity. The model was powered by as many as seven J-85 turbojet engines. Ingestion of hot exhaust gases by the engines proved to be strongly configuration dependent. The flow field created by a split arrangement of lift or lift-plus-lift/cruise engines caused intermittent localized ingestion of exhaust gases by the engine inlets which often resulted in large temperature gradients and distortion at the compressor face. The inlet thermal environment frequently caused engine stall, with the internal hot gases expelled from the stalled engine occasionally causing stall of adjacent engines. The test results showed that transient measurements with rapid-response thermocouples and recording equipment are needed for realistic assessment of the VTOL ground proximity thermal effects. Jet induced vertical forces and pitching moments were dependent on model height, wing location, engine grouping, number of engines, and model pitch attitude. Induced lift can be either positive or negative, depending on configuration and model height above ground. Sound pressure levels were primarily dependent on the height of the vehicle above the ground plane. Author

N68-28270# Aeronautical Research Labs., Melbourne (Australia).

FLIGHT-LOAD SPECTRA AND STRAIN PREDICTION EQUATIONS FOR CERES AIRCRAFT

R. S. Trayford Mar. 1967 22 p refs
(ARL/F-41) CFSTI: HC$3.00/MF$0.65

The flight loads on a Ceres aircraft were measured as applied normal accelerations while the aircraft was engaged on regular agricultural operations. Continuous recordings of the normal acceleration, strains at critical locations on the wing skin and other selected parameters were made over a period of 20 flying hours. The records were edited and collated to provide load spectra in the acceleration range encountered. Relationships were derived, using the technique of regression analysis, between the measured strains and relevant parameters. Author

N68-28277*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HOT-GAS INGESTION INVESTIGATION OF LARGE-SCALE JET VTOL FIGHTER-TYPE MODELS

H. Clyde Mc Lemore and Charles C. Smith, Jr. Washington Jun. 1968 258 p refs
(NASA-TN-D-4609) CFSTI: HC$3.00/MF$0.65 CSCL 01C

An investigation to study the problem of hot-gas ingestion was conducted in the Langley full-scale tunnel and outdoors on large-scale jet VTOL fighter-type aircraft configurations. The investigation included several rectangular and in-line exhaust-nozzle arrangements, inlet positions, and wing positions for a range of forward and side-wind conditions. The exhaust-gas source was a turbojet engine operating at a nozzle pressure ratio of about 1.8 and a nozzle temperature of 1200°F (649°C). The ingestion of hot-engine exhaust gases into the inlets was found to be very dependent upon the aircraft configuration and upon the wind speed. An in-line arrangement of engine exhaust nozzles resulted in virtually no hot-gas ingestion, whereas a rectangular arrangement of nozzles resulted in an inlet air temperature rise above ambient of 100°F to 200°F for many test conditions. The ingestion of hot exhaust gases was greatest at wind speeds from zero to 20 knots, and there was virtually no hot-gas ingestion than the side inlets, and the low-wing configuration was found to result in lower inlet air temperatures than did the high-wing configuration. Deflecting the jet exhaust 25° rearward with the vectoring nozzles generally eliminated the ingestion of hot exhaust gases. Author

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N68-27001# Leesona Corp., Great Neck, N. Y. Moos Labs.

DEVELOPMENT OF 24 VOLT, 25 AMPERE-HOUR AND 60 WATT, 720 WATT-HOUR ZINC/AIR BATTERY SYSTEMS Interim Technical Report, 16 Mar. 1966–16 Oct. 1967

B. Jagid and F. Staudinger Apr. 1968 79 p ref
(Contract DA-28-043-AMC-02082(E))
(ECOM-02082-1; Rept.-1; AD-668691)

The report describes work performed toward the development of two separate zinc/air battery systems conforming to the Electronics Command Technical Requirements SCL 6895 and SCL 6896. SCL 6895 calls for the development of a 60 watt- 720 watt-hour zinc/air battery with the capability of voltage selection in the range of 8, 16, 24 and 32 volts. Technical Specification SCL 6896 required the design, fabrication and evaluation of zinc/air batteries to power radio sets AN/PRC-41 and AN/PRC-47. The design target weight of this latter system is 10 pounds within the physical dimensions of length-11-5/8 in., width-4-3/16 in. and height-7-3/4 in. Voltage regulation was specified as 22 to 28 volts. The two battery systems were designed, fabricated and evaluated. Tests performed indicated that the 24 volt, 25 ampere-hour system can be discharged repeatedly (more than 20 times) against the AN/PRC-47 transceiver and still deliver rated capacity. Mechanical recharge of the system was demonstrated and was performed in less than the 10 minute requirement. Life studies were performed at LML and indicate that a battery life in excess of 50 recharges should be obtainable at the present time. The 60 watt- 720 watt-hour system was also evaluated. The system has delivered in excess of one kilowatt-hour at the 60 watt power level. Author (TAB)

N68-27006# Litton Systems, Inc., Minneapolis, Minn. Applied Science Div.

STUDY OF THERMIONIC CONVERTER ELECTRODE SURFACES USING THE ELECTRON MIRROR MICROSCOPE Final Report, 15 Jul. 1964–14 Jul. 1967

Kent N. Maffitt Feb. 1968 98 p refs
(Contract AF 19(628)-4302)
(Rept.-3183; AFCRL-68-0101; AD-668530)

Work function differences on polycrystalline tungsten are studied extensively by means of electron mirror microscopy. The electron mirror microscope (EMM) is shown to be a sensitive tool for correlating cesium adsorption with surface defects. EMM image formation is discussed qualitatively. The instrument response to potential gradients was quantitatively measured as a function of EMM parameters. Author (TAB)

N68-27066*# General Electric Co., Schenectady, N. Y. Research and Development Center.

PROCEDURE FOR OBTAINING FLUID AMPLIFIER RELIABILITY DATA

J. N. Shinn, F. A. Underwood, and G. J. Hahn Nov. 1965 69 p
(Contract NAS8-5408)
(NASA-CR-61849) CFSTI: HC$3.00/MF$0.65 CSCL 13G

Summary information is presented on the work performed to develop initial procedures by which data may be gathered and on which an assessment of fluid amplifier reliability may be made. A specific test directed toward evaluating the reliability of fluid amplifiers and a generalized failure report form were developed. Recommendations were submitted for procedural improvements and expanded scope, to better understand the physics of fluid amplifier failures. Author

N68-27109# Army Electronics Labs., Fort Monmouth, N. J.

STANDARD ALKALINE CELLS AND SECONDARY BATTERIES

Erminio J. Settembre Mar. 1968 31 p
(ECOM-2949; AD-668654)

The physical and electrical characteristics for a family of cells and batteries of the Nickel-Cadmium, Cadmium-Silver Oxide and Zinc-Silver Oxide electrochemical systems are presented. Four cell sizes exist for each system which are used in standard batteries of man-pack and detached configurations. Standard batteries are housed in fiberglas reinforced plastic cases designed to withstand severe environmental and mechanical requirements. The flexibility and interchangeability to be derived from standard batteries was enhanced by incorporating in each battery the capability of operation at two voltages and two capacity levels. Design, physical and electrical characteristics, availability and future plans are presented. Author (TAB)

N68-27133# Alabama Univ., University. Bureau of Engineering Research.

AN INVESTIGATION OF A SUPERSONIC FLUID AMPLIFIER Final Report

Richard R. Scott 29 Feb. 1968 136 p refs
(Contract DA-01-021-AMC-15570(Z))
(AD-668682)

Results of an analytical and experimental investigation of a supersonic fluid amplifier are presented. An analysis is presented by which the bistable state of a supersonic amplifier can be described. One-dimensional assumptions are made in order to determine the fluid properties before the fluid separates from the nozzle bouhdary. The area ratio and Mach Number at separation are predicted by assuming that the particles moving along a characteristic streamline in the boundary layer flow into a stagnation region. The location of the stagnation region and the strength of the oblique shock initiated at that boundary determine whether the separated free stream boundary at that surface is deflected into the opposite exit channel or flows out the adjacent exit channel. The location of the stagnation region is predicted in terms of the specific heat ratio and the chamber to discharge pressure ratio. Results from both theoretical equations and experimental data are presented in graphical form. An analysis is presented and an equation is derived to predict switching times. The analysis is based on a control volume located at the control port region. Experimental switching times determined from high speed schlieren film are tabulated for nitrogen and hydrazine at chamber pressures of 1200 and 1000 psig. Author (TAB)

N68-27340# General Electric Co., Schenectady, N. Y. Research and Development Center.

STUDIES ON THERMIONIC ENERGY CONVERSION Final Report, 16 Aug. 1964–15 Aug. 1967

John M. Houston and Harold F. Webster Apr. 1968 158 p refs
(Contract AF 19(628)-4339)
(S-68-1036; AFCRL-68-0058; AD-669106)

The work described in the report was divided into nine sections. The first two sections deal with the thermionic emission of the platinum and thorium group metals in cesium vapor. Sections III through V treat investigation of the optical emissivity, vacuum work function, and diffusion in tungsten of os nium metal. Sections VI and VII describe experiments with a double crystal thermionic converter and the wetting of several metals by liquid cesium and sodium, respectively. Sections VIII and IX are concerned with low-energy electron diffraction dealing, respectively, with a new type of low-energy electron diffraction system and an electron diffraction analogue by using light diffraction with two-dimensional lattices. Author (TAB)

N68-27381*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A SURVEY OF POTENTIAL APPLICATIONS OF FLUIDICS TO SPACECRAFT ATTITUDE CONTROL

H. D. Garner and H. V. Fuller, Jr. [1967] 34 p refs Presented at the SAE Comm. A-6 Symp. on Fluidics, San Francisco, 21 Oct. 1966
(NASA-TM-X-59968) CFSTI: HC $3.00/MF $0.65 CSCL 13G

The Lunar Orbiter vehicle attitude control system specifications have been used as a general basis for system analysis. The attitude control is analyzed on a block diagram basis, the function and present design of each block being briefly described. Suggested schemes for fluidic implementation of each block are discussed, and the approaches are compared in terms of relative power consumption, weight, and reliability. Although a complete fluidic attitude control system does not appear feasible within the present state of the art, several areas may well profit by conversion to fluidic hardware. Prime areas for fluidics appear to be thrust vector control and the inertial reference unit, while the fluid power supply and electronic-to-fluidic interfaces are major problem areas. Author

N68-27449*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DEVELOPMENT OF HIGH SPEED FLUERIC LOGIC CIRCUITRY FOR A NOVEL PNEUMATIC STEPPING MOTOR

William S. Griffin and William C. Cooley [1967] 37 p refs Presented at Symp. on Fluidics, Lafayette, Ind., 8–10 May 1967; Sponsored by ASME and Harry Diamond Labs.
(NASA-TM-X-59868) CFSTI: HC $3.00/MF $0.65 CSCL 13G

Under a NASA-Lewis Research Center program aimed at nuclear rocket control drum actuator improvement, a novel, pneumatic stepping motor has been developed. This paper describes improved, NASA-developed high speed flueric logic circuitry to drive the motor, the breadboard performance of the logic circuitry-stepping motor system, and finally compares the pneumatic stepping motor actuation system with the more conventional pneumatic piston-in-cylinder actuator. Author

N68-27465*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SUMMARY OF NASA RADIAL TURBINE RESEARCH RELATED TO BRAYTON CYCLE SPACE POWER SYSTEMS

H. E. Rohlik, M. G. Kofskey, and T. Katsanis Washington 1967 22 p refs Presented at 2d Interagency Energy Conversion Eng. Conf., Miami Beach, Fla., 13–17 Aug. 1967
(NASA-TM-X-52298) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Progress to date at the Lewis Research Center is reported in two areas, new techniques for turbine analysis and experimental investigations of turbine performance. Radial-flow turbines were investigated for effects of size, Reynolds number, and specific speed on efficiency and flow. Results indicate that turbines for wide ranges of operating variables may be designed with a reasonable certainty of achieving high efficiency. Author

N68-27468*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WALL ATTACHMENT CROSSOVER AND GATE

R. F. Hellbaum [1967] 11 p ref Presented at the ASME 4th Fluidics Symp., Chicago, 9–11 May 1967
(NASA-TM-X-59871) CFSTI: HC $3.00/MF $0.65 CSCL 13G

A new and improved flueric "and" gate, using the wall attachment principle, has been constructed and tested. The principle of operation and static performance data are presented in this report. Tests indicate its performance is not adversely affected by normal dimensional variations encountered in fabrication and it will operate throughout the full range of loading from fully open to fully blocked output. Author

N68-27471*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

VORTEX VALVE PERFORMANCE POWER INDEX

Vernon D. Gebben [1967] 20 p refs Presented at Symp. on Fluidics, Lafayette, Ind., 8–10 May 1967
(NASA-TM-X-59869) CFSTI: HC$3.00/MF$0.65 CSCL 13G

The pressure, flow, and power characteristics of a vortex valve are altered by changing the geometry of the unit. An index was developed for evaluating changes in the power consumption. This index is considered to be an important parameter which should be examined during the design of an optimized vortex valve. The power index is determined by the ratio of the maximum radial inlet power to the tangential inlet power required to stop the radial inlet flow. Characteristics and applications for the power index are illustrated by results from an experimental investigation. Author

N68-27541*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SOLAR CELL RADIATION EXPERIMENT ON THE EXPLORER 23 MICROMETEOROID SATELLITE

Walter E. Ellis and James Bene [1967] 28 p refs Presented at the Virginia Acad. of Sci. Ann. Meeting, Norfolk, Va., 5–6 May 1967
(NASA-TM-X-60138) CFSTI: HC$3.00/MF$0.65 CSCL 10A

The presence of energetic electrons and protons trapped in the earth's magnetic field presents a hazard to man's exploration of space, both to personnel in manned missions, and to certain materials and components used in the construction and operation of the spacecraft. Solar cells, widely used on spacecraft to convert sunlight to electrical power, are particularly vulnerable to these energetic particles. Transparent shields are almost universally used in solar cell space power systems to provide some protection from particulate irradiation. Weight considerations, however, often limit the amount of shielding that can be effectively employed. The objective of the solar cell radiation damage experiment on the Explorer XXIII satellite was to determine the effects of particulate irradiation on the performance of shielded and unshielded silicon solar cells while operating in the near-earth environment. This was accomplished by monitoring their output voltages while they were operating in space into fixed resistive loads, and comparing the results with initial voltages obtained from ground calibrations, and from flight data received soon after injection into orbit. Author

N68-27548*# American Univ., Washington, D. C.

RESEARCH INTO FUNDAMENTAL PHENOMENA ASSOCIATED WITH SPACECRAFT ELECTROCHEMICAL DEVICES: CALORIMETRY OF NICKEL-CADMIUM CELLS Progress Report, 1 Jul.–30 Sep. 1967

G. D. Mitchell and R. T. Foley 30 Sep. 1967 13 p refs
(Contract NAS5-10105)
(NASA-CR-95252; PR-5) CFSTI: HC$3.00/MF$0.65 CSCL 10C

The objectives of this project are to train electrochemists in the area of battery research and to collect electrochemical and thermodynamic data of value to projects being conducted at the Goddard Space Flight Center. The work completed during this reporting period involved measuring the thermal characteristics of a 20 ampere-hour nickel-cadmium cell during 90-minute cycles including 30-minute discharge at 25% depth and 60-minute charge at 105% rate. The data tabulated from the experiment were taken from the selected orbits. The parameters measured during the course of the experiment were, the thermal output, the electrical work, the cell potential, the pressure transducer signal, and the Adhydrode signal. The maximum thermal output of 4 watts is tentatively reported, recognizing that its variation from other measurements must be explained by further investigation. The enthalpy (ΔH) of reaction was calculated from this experiment as 31.5 Kcal/equiv.. The relationship between the above cell parameters during the experiment were also observed and discussed. Author

N68-27563*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DEVELOPMENT OF ELECTRIC COMPONENTS FOR A 400 HERTZ BRAYTON CYCLE ENERGY CONVERSION SYSTEM

Charles S. Corcoran and Leroy J. Yeager (GE, Erie, Pa.) Washington 1967 17 p Presented at the 2d Intersoc. Energy Conversion Eng. Conf., Miami Beach, Fla., 13–17 Aug. 1967
(NASA-TM-X-52312) CFSTI: HC$3.00/MF$0.65 CSCL 10A

This paper summarizes the design and the developmental testing of the major electrical components required for a two shaft Brayton cycle electric generating system. Several unique approaches were incorporated in the Brayton cycle system to enhance the reliability and efficiency. This development is also the first to utilize gas bearings for a turboalternator designed for use in space. The gas bearings required that unbalanced flux and the resultant forces be minimized. Author

N68-27564*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PERFORMANCE OF AN EXPANDABLE WHIRLING MEMBRANE SOLAR ENERGY CONCENTRATOR

John M. Jerke [1967] 16 p refs Presented at the 3d Aerospace Expandable and Modular Struct. Conf., Miami Beach, Fla., 16–18 May 1967
(NASA-TM-X-59872) CFSTI: HC$3.00/MF$0.65 CSCL 10A

The whirling membrane solar energy concentrator is a preformed approximate paraboloid constructed of an aluminized plastic film which is attached to a fixed hub. The concentrator is deployed by rotation about the optical axis, and the membrane assumes the desired paraboloidal shape under the stresses imposed by centrifugal and axial loading. The concentrating ability of three whirling membrane models was determined by optical ray trace methods and the results of the investigation are presented. Dispersion of the reflected optical image in the focal plane occurred for all three models. This undesirable energy spread probably resulted from circumferential wrinkles and a deviation in the circular shape of the membrane similar to cusping or scalloping. Comparison of data for the models shows that the two larger hub models developed considerably less circumferential wrinkling than the smallest hub model. A parabolic radial cross section was generally attained for each model, but with focal distances slightly less than the design value. Estimation of the geometric efficiency indicates that the whirling membrane concentrator is applicable for relatively low-temperature space power conversion systems. Author

N68-27643*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

REVIEW OF SOLAR CONCENTRATOR TECHNOLOGY

Atwood R. Heath, Jr. and Edward L. Hoffman [1967] 19 p refs Presented at the Intersoc. Energy Conversion Eng. Conf., Los Angeles, 26–28 Sep. 1966
(NASA-TM-X-59043) CFSTI: HC$3.00/MF$0.65 CSCL 10A

Continuing development of solar concentrator technology has been directed toward the improvement of methods and materials of construction to satisfy the particular design requirements of various space power conversion devices. Descriptions of fabrication techniques as well as a brief discussion of recent results from investigations made on concentrators are presented. In the area of one-piece concentrators, the stretch-formed aluminum process has been developed to the point where concentrator accuracy compares favorably with the high quality formerly obtained only by electroforming nickel. The aluminum electroforming process has been scaled up to the point where 0.76-meter-diameter concentrators have been fabricated. In the area of expandable concentrators, a modified model of the whirling membrane concept has given improved concentration of energy, however, the design parabolic cross section has not been attained. Author

N68-27645*# Douglas Aircraft Co., Inc., Newport Beach, Calif.
Astropower Lab.

SEALING OF SILVER OXIDE-ZINC STORAGE CELLS

Quarterly Report, 23 Dec. 1967–23 Mar. 1968
23 Mar. 1968 42 p refs
(Contract NAS5-10409)
(NASA-CR-94104; DAC-59860-Q3) CFSTI: HC $3.00/MF $0.65
CSCL 10C

In the continuing evaluation of miniature hybrid fuel cells for controlling pressure, tests were conducted on 24 sealed assemblies consisting of a composite silver oxide–zinc cell and dual micro fuel cell assembly. The program included stand tests at both room temperature and 0° C, operation on a continuous 24-hour cycle regime, and a 90-minute cycle mode. The results obtained indicate: (1) In low gassing rate environments such as were found on the open circuit stand or on the 24-hour cycle regime, the micro fuel cells performed their function effectively in the primary mode of operation. (2) In high gassing rate environments such as the 90-minute cycle mode, the micro fuel cells had to be recharged in order to satisfactorily perform their function. An improved method for charging Cd micro fuel cells is proposed, based on the use of the Ag–Zn cells themselves as sources of energy. M.G.J.

N68-27684*# National Aeronautics and Space Administration. Washington, D. C.

TOWARD IMPROVED PRIMARY ELECTROCHEMICAL POWER SYSTEMS

Ernst M. Cohn [1967] 8 p Presented at the Intersoc. Energy Conversion Eng. Conf., Los Angeles, 26–28 Sep. 1966
(NASA-TM-X-59054) CFSTI: HC$3.00/MF$0.65 CSCL 10B

Primary electrochemical power producers, batteries and fuel cells may be used for seconds or up to months. They must meet many special requirements, such as long storage, unusual operating temperatures, multiple starts, sterilizability, resistance to impact of several thousand G, and a multiplicity of electric outputs. Efforts are constantly continuing to make them more reliable, efficient, and powerful per pound and per cubic foot. Hydrogen recombination devices have become available to extend the shelf and operating life of silver-zinc batteries. A multiple-reserve dry-tape battery may approach the long-sought goal of 200 watt-hours per pound. The hydrazine-air fuel cell promises early military use. An alcohol-air fuel cell is being considered for application in Europe. Hydrogen-oxygen fuel cells are shrinking in size and weight while useful life is increasing. Key problems are non-aqueous electrolytes for batteries and fuel-cell catalysts and engineering. I have arbitrarily limited myself to descriptions of a few items, be they hardware or little more than bright ideas as yet, from which we shall derive a formulation of some of the key problems awaiting solution in the improvement of electrochemical power systems. Author

N68-27926*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PERFORMANCE OF AN EXPANDABLE WHIRLING MEMBRANE SOLAR ENERGY CONCENTRATOR

John M. Jerke *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 167–180 (See N68-27917 16-32)
(L-5484)

Results of a program to investigate the whirling membrane solar concentrator concept are presented. An optical ray trace method was employed to estimate such concentrator properties as shape, focal length, and geometric efficiency. Three 3.05-m diameter models with ratios of hub diameter to concentrator diameter of 0.20, 0.35, and 0.50 were examined and results are given for each model. All models generally achieved a parabolic radial cross section, but with focal lengths of 130.7 centimeters, 129.1 centimeters, and 128.2 centimeters for the 0.20, 0.35, and 0.50 hub models, respectively. Comparison of the data for the three models shows that there was considerably less circumferential wrinkling in the 0.35 and 0.50 hub models, which were similar in behavior, than in the 0.20 hub model. Estimation of the geometric efficiency at various aperture ratios for the 0.50 hub model indicated that the whirling membrane has a concentrating ability comparable to two other expandable-type solar concentrators, and inflatable-rigidized and split-rib umbrella, which also use an aluminized plastic membrane. The whirling membrane appears to be capable of efficient operation (greater than 0.90) in the aperture ratio range near 0.04 which would make it applicable for relatively low temperature space power conversion systems. Author

N68-27942# Fairchild Hiller Corp., Bay Shore, N. Y. Space and Electronics Systems Div.

POSITIVE DEPLOYABLE SOLAR ARRAY

Thomas Berry *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 515–528 (See N68-27917 16-32)

The development, fabrication, and testing of a deployable solar array for a spin oriented spacecraft application is described. The approach used employs a flexible substrate erected by a linkage extension system. The motive power for deployment is provided by potential mechanical energy stored in springs. Significant design requirements were: (1) a 2π steradian field of view; (2) deployment at spin rates up to 160 RPM; (3) self-supporting horizontally under 1 g conditions; (4) capable of withstanding shock, vibration and acceleration of launch; and (5) the use of non-magnetic state of the art, space qualified materials. Developed and tested was a 2.16 foot wide by 8.20 foot long flexible array system. The material chosen for the array substrate was a 3-mil Kapton film having very high radiation resistance and a zero strength temperature of 800°C. Testing included vibration, humidity and spin deployment of the complete system, and humidity, vibration, tension-fatigue and thermal cycling of a sample array. Drive and extension mechanism, release mechanism, brake system, and structural design details for the deployable solar array are detailed. During testing no malfunction or serious damage occurred to any of the components or to the mechanism itself. Results indicated that: (1) the proposed deployable solar array concept is feasible and represents an improvement in weight and packaged volume over existing photovoltaic systems; (2) the concept of a flexible substrate for single crystal silicon solar cells is feasible; (3) the mechanical system used for deployment although not overly sophisticated functioned well under test conditions; (4) the method of attaching the cells to the substrate, and the interconnection for the cells, methods of handling and the necessary data on roll diameter and roll buildup were established. S.C.W.

N68-27974*# TRW Systems Group, Redondo Beach, Calif.

MARINER MARS POWER SYSTEM OPTIMIZATION STUDY

Interim Report, 4 Mar.–31 May 1968
F. S. Osugi May 1968 41 p Prepared for JPL
(Contracts NAS7-100; JPL-952151)
(NASA-CR-95263; TRW-E-7443-3-024) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The prime objective of the study is directed toward the development of an optimum Mariner-class spacecraft power system to provide improved utilization of solar array capacity and greater reliability than the present Mariner-Mars power system. The two missions identified for this study project are a Mars flyby and a Mars orbiter. Author

N68-28033*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NIMBUS POWER SYSTEMS (1960–1969)

Charles M. MacKenzie, Richard C. Greenblatt (RCA, Princeton, N. J.), and Arnold S. Cherdak (RCA, Princeton, N. J.) Jun. 1966 30 p refs Presented at the Aerospace Electron. Systems Conv., Washington, D. C., Oct. 1966
(NASA-TM-X-63245; X-450-66-333) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The evolution of the power supply subsystems designed for use on the Nimbus spacecraft is described. The original design, generated during the period 1961–1963, used dissipative regulation techniques and simple battery protection circuits. Battery overcharge protection was provided by ground control of special spacecraft loads. The second generation design, currently being fabricated for test and evaluation, is intended for operational flight use in late 1967. The system concept, based on research and development effort in the period 1962–65, incorporates nondissipative regulation techniques and automatic battery overcharge control. A new concept, intended for use in a third generation Nimbus power system, is presently being explored. Recent advances in power conditioning technology will allow substantial gains in terms of extended spacecraft life or increased load capability. The new technology, called maximum power point tracking, assures more optimum source-to-load energy transfer. Author

N68-28101*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EVALUATION OF ALTERNATING-CURRENT LINE-VOLTAGE REGULATORS IN AUXILIARY ELECTRIC POWER SYSTEMS
Richard R. Secunde and James E. Vrancik Washington Jul. 1968 19 p refs
(NASA-TN-D-4627) CFSTI: HC$3.00/MF$0.65 CSCL 09E

The operation of ferroresonant and feedback alternating-current line-voltage regulators in a 15-kilowatt auxiliary power system was experimentally evaluated. Input current harmonics, transient response, input–output voltage harmonic isolation, and efficiency were measured and are discussed. Author

N68-28151# Argonne National Lab., Ill.
GALVANIC CELLS WITH FUSED-SALT ELECTROLYTES
E. J. Cairns, C. E. Crouthamel, A. K. Fischer, M. S. Foster, J. C. Hesson et al Nov. 1967 219 p refs
(Contract W-31-109-ENG-38)
(ANL-7316) CFSTI: HC$3.00/MF$0.65

The thermally regenerative bimetallic galvanic cells discussed use a relatively volatile liquid-alkali metal having a low electro-negativity for the anode, and a relatively nonvolatile liquid metal of high electronegativity for the cathode. The anode metal is oxidized to form a cation which migrates through the fused-salt electrolyte to the cathode, where it is electrochemically reduced, forming an alloy with the cathode metal. The electrons released at the anode travel through the electrical circuit to the cathode. The cathode alloy circulates from the cell to a high-temperature regenerator (1050 to 1600°K), where the anode metal is vaporized away from the cathode metal. The anode metal vapor is condensed and returned to the anode compartment of the cell, completing the cycle. The process is Carnot-cycle limited. In selecting suitable anode metal–cathode metal pairs, the proper electronegativity differences must be chosen so that the alloy can be separated at reasonable regenerator conditions while still maintaining an appropriate cell voltage (0.5 to 0.7 V). Author (NSA)

N68-28280*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF RADIATOR CHARACTERISTICS OF A SINGLE-LOOP 100-KILOWATT BRAYTON SPACE POWER SYSTEM USING A PURE GAS AND A GAS-SOLID SUSPENSION
Robert Pfeffer (City Coll. of the City of New York), Salvatore Rossetti (City Coll. of the City of New York), and Seymour Lieblein Washington Jul. 1968 68 p refs
(NASA-TN-D-4659) CFSTI: HC$3.00/MF$0.65 CSCL 22B

Results are presented for an exploratory comparative analysis of radiator geometric characteristics based on a simplified radiator model with either a pure gas or a graphite-gas suspension working fluid. Radiator variables investigated were gas-flow Reynolds number, pressure-drop fraction, and suspension-particle loading ratio. For the pure gases, type of gas and Reynolds number had a pronounced effect on tube and panel geometry, but Reynolds number and pressure drop fraction had a relatively small effect on planform area for fixed overall cycle loss pressure ratio. Only moderate reductions in radiator planform area (10 to 17 percent) were indicated with the use of graphite-gas suspensions. Author

N68-28310*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A RADIATOR CONCEPT BASED ON CAPILLARY RETENTION OF LIQUID
Alex Vary Washington Jul. 1968 45 p refs
(NASA-TN-D-4370) CFSTI: HC$3.00/MF$0.65 CSCL 13A

A preliminary study was made to define problem areas and potential advantages of a radiator for extraterrestrial applications in which a heat exchange liquid is circulated through a capillary medium. An evaluation of surface energy, heat transfer, hydraulic, geometric, and meteoroid penetration factors in a capillary radiator operating under extraterrestrial conditions is presented to indicate feasibility in a potential application. Author

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N68-28960# Aerospace Medical Div. Aerospace Medical Research Labs.(6570th), Wright-Patterson AFB, Ohio.
AUTOMATED TRIHYDROXYINDOLE PROCEDURE FOR ANALYSIS OF EPINEPHRINE AND NOREPINEPHRINE Final Report, Jun. 1966–Feb. 1967
Plummer A. Sampson, Jr. Dec. 1967 24 p refs
(AMRL-TR-67-96; AD-669073)

A trihydroxyindole procedure for the fluorometric analysis of epinephrine and norepinephrine in urine has been adapted to the Technicon Autoanalyzer. Modifications of the original method of Robinson and Watts include: (1) the use of an alkaline sodium acetate buffer in the column wash, and (2) substitution of 0.1N sodium acetate pH 6.0 in the diluent stream of the autoanalyzer. Twenty-four hr urine specimens from 10 normal subjects were analyzed, giving values of norepinephrine 29.4 micrograms plus or minus 8.1 (standard deviation) 24 hrs, epinephrine 6.6 plus or minus 3.5 and total catecholamines 36 plus or minus 10.7. Repeatibility of 10 aliquots of a single specimen was 32.8 plus or minus 1.7 standard deviations (plus or minus 5%) for norepinephrine, 9.3 plus or minus 0.7 standard deviations (plus or minus 7%) for epinephrine and 42.1 plus or minus 1.6 (plus or minus 4%) for the total catecholamines. Reproducibilities of duplicate aliquots of a single specimen analyzed on 3 different days were 26.1 micrograms plus or minus 2.3 (plus or minus 9%) for norepinephrine and 6.9 plus or minus 0.9 (plus or minus 11%) for epinephrine and 33.6

plus or minus 1.5 (plus or minus 4%) for the total catecholamines. Interference between large and small known samples run sequentially in the analyzer was not seen. Recoveries of columned aliquots was 83 plus or minus 5.4% for norepinephrine, 75 plus or minus 5% for epinephrine and 79 plus or minus 4.6% for the total catecholamines. Automation of the analysis and digital computer computation of the calculations will permit up to 210 analyses per week by a single technician. Author (TAB)

N68-27004# Army Forces Radiobiology Research Inst., Bethesda, Md.

IMPLANTATION OF ECG ELECTRODES, EEG ELECTRODES AND TEMPERATURE THERMISTORS IN THE MONKEY (MACACA MULATTA)

P. Carmeci, W. F. Davis, Jr., D. F. Dixon, Jr., and D. W. De Young
Dec. 1967 23 p refs
(AFRRI-TN67-6; AD-669077)

Methods and procedures of bioinstrumentation for the long-term monitoring of the electrocardiogram, body temperature, and the electroencephalogram are discussed. These techniques were designed specifically to facilitate psychophysiological investigation of preirradiated and postirradiated monkeys. The instrumentation herein described has performed satisfactorily throughout an exposure to a gamma-neutron radiation pulse of 5000 rads with no appreciable decrement. Author (TAB)

N68-27170# Picatinny Arsenal, Dover, N. J. Feltman Research Labs.

A MODEL FOR THE STUDY OF RETINAL DAMAGE DUE TO LASER RADIATION

James H. Fahs Feb. 1968 49 p refs
(PA-TR-3678; AD-668906)

A model is proposed for the prediction of retinal damage as a result of laser radiation striking the eye. The differential equation for heat conductivity is replaced by a numerical difference equation and a FORTRAN computer program is presented which will solve the equation for given input. A sample case is shown and program listings are given. Author (TAB)

N68-27184# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.

THE RELATIONSHIP BETWEEN STIMULUS-ORIENTED CHANGES IN HEART RATE AND DETECTION EFFICIENCY IN A VIGILANCE TASK Final Report, Jun. 1965–Jun. 1967

Austin W. Kibler Feb. 1968 73 p refs
(AMRL-TR-67-233; AD-668758)

The study was designed to assess the relationship between detection efficiency and beat-to-beat changes in heart rate around task stimuli in a vigilance task. Thirty-six subjects, instrumented for continuous recording of EKG and respiration, individually stood a 96 minute vigil. They monitored a light which flashed on (stimulus event) for 500ms. once every 6.0 seconds and were to report the occasional brighter flashes (signals). Half of the subjects (high signal density group) received 240 signals; the remaining 18 subjects (low signal density group) received but 16 signals. By urging the subjects to do their best, a motivational condition was induced in a six minute post-test. As expected, detection efficiency was higher and better sustained by the high signal density group. Detection efficiency of the low signal density group decayed appreciably over time. In the motivational post-test condition the performance of both groups improved significantly. Measures of changes in heart rate, analyzed both in terms of overall shifts in heart rate over the vigil and beat-to-beat changes in heart rate around each stimulus event, revealed: (1) The median heart rate in succeeding quarters of the vigil, did not differ significantly between the two groups. (2) Heart rate preceding a stimulus event decelerated. (3) In the post-test the significant recovery in detection efficiency was accompanied by an increase in the magnitude of stimulus-oriented cardiac deceleration and by a decrease in overall heart rate. Author (TAB)

N68-27188 Michigan Univ., Ann Arbor.

HUMAN PERFORMANCE IN LOW SIGNAL PROBABILITY TASKS

Patrick Anthony Lucas (Ph.D. Thesis) 1966 84 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8304

An extension of the theory of signal detection (TSD) to psychophysical tasks involving low probability signals and free response data is developed and evaluated. Emphasis is placed on tasks for which the observer is asynchronous; that is, the observer cannot perform optimally by making independent decisions on non-overlapping intervals of time. A mathematical model of asynchronous observation in a class of temporally unstructured tasks with Neyman–Pearson solutions for optimal fixed response rate is used to describe detection performance by human observers. Data from the above experiment show for all observers, a conservative fixed response rate, a constant hit rate, and inter-response distributions for false alarms with a general exponential shape showing periodic modes. A *post hoc* analysis of the effect of training showed an effect for distribution of responses in time but showed no effect of an improvement in memory for the signal. It is concluded that highly trained observers detecting important signals show constant efficiency over observation periods of 30 to 45 minutes. Dissert. Abstr.

N68-27349# Naval Submarine Medical Center, Groton, Conn.

LASER-INDUCED PATHOLOGY OF THE RABBIT RETINA: COMPARISON OF THREE RADIATION WAVELENGTHS

Paul R. Kent, James A. E. Spencer, Grover A. Smithwick, and Louis Zglobicki 15 Mar. 1968 15 p refs
(MR-68-4; AD-669117)

Since laser radiation consists of essentially parallel rays, the wavelengths to which the ocular media is relatively transparent are focused by the eye at or near the fundus, greatly concentrating the energy in the process. Because retinal damage can result, the differential effects in terms of wavelength and power levels is of considerable importance. In this study damage to the rabbit retina was induced by irradiation with neodymium, ruby, and frequency-doubled neodymium lasers. The neodymium laser (wavelength 10,600 angstroms) produced the smallest lesions and least damage. The ruby (6943 A) and frequency-doubled neodymium (5300 A) lasers caused lesions similar in size and seven day post-irradiation histo-pathology, except for inter-layer adhesion differences. Author (TAB)

N68-27398* California Univ., Los Angeles. School of Medicine.

SELECTION OF ANTIBIOTICS IN ACUTE PYELONEPHRITIS BASED ON RENAL INTERSTITIAL (LYMPH) CONCENTRATIONS

A. T. K. Cockett, A. P. Roberts, R. S. Moore, and W. E. Goodwin [1967] 9 p refs Presented at the Ann. Meeting of the Western Sect. of the Am. Urol. Assoc., Inc., Honolulu, Hawaii, 18–24 Jun. 1967 Prepared jointly with Harbor Gen. Hosp., Torrance, Calif.
(Grant NsG-237-62; PHS-GHE-09834-03)
(NASA-CR-89910) CFSTI: $3.00 CSLC 06M

Experiments were conducted on mongrel dogs to determine the distribution of cycloserine and oxytetracycline in renal lymph, urine, and plasma. The data show that for cycloserine, renal lymph levels exceed the corresponding plasma concentrations in almost all instances. Renal lymph levels of oxytetracycline exceed the corresponding plasma in the early post-injection periods; the lymph levels then decline to lesser concentrations which are equal to or less than the corresponding plasma levels. Urinary levels range from several hundred micrograms to levels of 40 to 50 micrograms several hours later. The findings suggest that cycloserine may well be the most effective agent in treating renal tuberculosis. Comparisons on the lymphatic distribution of nitrofurantoin show that hilar lymph concentrations are higher than corresponding cisterna chyli lymph concentrations. Renal lymph concentrations, however, are several times higher than the plasma levels many hours after administration of the drug. M.G.J.

N68-27436*# Indiana Univ., Bloomington. Center for Neural Sciences.

THE AUDITORY DISCRIMINATION BEHAVIOR OF MONKEYS: BRIDGE OR BARRIER

Jonathan G. Wesener [1966] 11 p refs Presented at the 8th Intern. Cong. of Audiology, Mexico City, 6–10 Nov. 1966
(Grant NGR-15-003-007)
(NASA-CR-82338) CFSTI: HC$3.00/MF$0.65 CSCL 06C

Experimental studies of the structure and function of the auditory system have in the past usually used as the objects of investigation animal species below the level of primates. Increasingly, primates are being used as subjects in studies of normal and impaired discrimination behavior. In the context of the data gathered from experimental studies of audition in sub-primate species, this paper will present some data gathered from the study of normal and brain damaged monkeys. This data can then be evaluated to determine whether it is at variance with data from lower species, is identical to the data from lower animals, narrows some of the gaps between existing animal experimental studies and human clinical observations, or confuses the picture by uncovering, species-specific auditory behavior. Author

N68-27438*# Purdue Univ., Lafayette, Univ. Dept. of Agronomy.

EFFECT OF WATER PROPERTIES IN THIXOTROPIC CLAY SYSTEMS ON BIOLOGICAL ACTIVITY Final Report

Philip F. Low 20 May 1968 18 p
(Grant NGR-15-007-004)
(NASA-CR-95220) CFSTI: HC$3.00/MF$0.65 CSCL 06C

Research was undertaken to study the properties of water in clay systems and to determine how a change in these properties, occasioned by disturbances that rearrange the particles, affects biological activity. Test results indicated that the properties of water near the surfaces of clay particles are different than those of bulk water and that particle arrangement influences these properties. Also, it was found that the germination of lettuce seeds and the thermogenesis of bacteria in these systems are affected by disturbances that alter the properties of the water. A.L.

N68-27463*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

APPROACHES TO THE CHEMICAL SYNTHESIS OF FOOD

J. Shapira [1967] 22 p refs Presented at the 52d Ann. Meeting, Los Angeles, Apr. 1967
(NASA-TM-X-59839) CFSTI: HC$3.00/MF$0.65 CSCL 06H

The conversion of human metabolic products such as carbon dioxide, water, and urea into materials which might be used as food furing extended space missions has been of concern to the NASA for some time. A relatively new approach to this problem is to synthesize by purely chemical methods compounds which would satisfy a major portion of the astronaut's calorie requirements. Formose sugars, which can be readily prepared from formaldehyde, represent one such potential food. Unfortunately, crude as well as partially purified formose is toxic to weanling rats when fed at high levels. This toxicity may be due to materials which can be eliminated by proper modification of the catalyst, reaction conditions, or methods of purification. An alternative chemically synthesized food is represented by glycerol and some of its derivatives. In this case, there has been much greater success in feeding studies. Individually up to 40% by weight of some of these compounds was compatible with good growth. An even higher total concentration of certain combinations of these low molecular weight materials was tolerated. The feasibility of actually synthesizing these compounds in the space environment has been explored. Author

N68-27617*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SYNTHESIS OF ORGANIC COMPOUNDS BY THE ACTION OF ELECTRIC DISCHARGES IN SIMULATED PRIMITIVE ATMOSPHERES

C. Ponnamperuma, F. Woeller, J. Flores, M. Romiez, and W. Allen [1967] 9 p refs Presented at the 153d Natl. Meeting of the Am. Chem. Soc., Miami Beach, Fla., 9–14 Apr. 1967
(NASA-TM-X-59854) CFSTI: HC$3.00/MF$0.65 CSCL 06A

Experiments designed to simulate some of the reactions which may have taken place on the prebiotic earth, through the action of electric discharges, are described. Four different classes of experiments were performed: with methane; with methane and ammonia; with methane, ammonia, and water; and with methane and water. The most relevant experiments involved the use of all the main constituents of the presumed primitive earth atmosphere - methane, ammonia and water. A mixture was exposed to a discharge from a tesla coil for a period of 24 hours. Gas phase analysis showed that over 90% of the starting methane had been converted into organic compounds. Paper chromatography also revealed that a large number of organic compounds were formed but none corresponded to the commonly occuring amino acids. Results of the different experiments reveal that important biological molecules can be synthesized by the use of a form of energy which existed on the primitive earth, and that the conditions may be considered to be genuinely abiotic since the materials used are the constituents of the presumed primitive earth atmosphere, the conditions are aqueous, and the form of energy one that is likely to have occurred on the earth before the appearance of life. A.L.

N68-27635*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE ROLE OF RADIATION IN PRIMORDIAL ORGANIC SYNTHESIS

Cyril Ponnamperuma [1966] 26 p refs Presented at the 3rd Intern. Radiation Res. Congr., Cortina, Italy, 26 Jun.–7 Jul. 1966
(NASA-TM-X-57965) CFSTI: HC$3.00/MF$0.65 CSCL 06C

The primitive atmosphere of the earth is discussed from the view point that the principle constituents must have been water vapor, ammonia, and methane, and that the energy available for synthesis of organic compounds were ultraviolet light from the sun, electric discharges, ionizing radiation, and heat. Several experiments were conducted with ionizing and ultraviolet radiation. In the experiments starting with methane, ammonia, and water, an electron beam was used to simulate potassium 40 on the primitive earth. Other experiments used a gamma ray cell, cobalt 60, and ultraviolet light as a radiation source. The purpose of these experiments was to establish the formations of the purines, adenine, and guanine, and the sugars, ribose and deoxribose. Other simulation experiments were performed in which the starting materials were adenine, adenosine, adenosine monophosphate, and adenosine diphosphate. The photochemical synthesis of peptides was also investigated. Results showed that under simulated primitive earth conditions, molecules of biological significance can be synthesized by the ionizing or ultraviolet radiation. This lends support to the hypothesis of chemical evolution, since not only can primary molecules be made by this process but, once made they can undergo condensation reactions to form compiles compounds. B.S.D.

N68-27647*# Public Health Service, Phoenix, Ariz. Planetary Quarantine Unit.
[RESEARCH ON MICROBIOLOGICAL STERILIZATION PROBLEMS] Progress Report, Apr.–Jun. 1968
M. S. Favero Jul 1968 15 p
(NASA Order R-137)
(NASA-CR-95228; PHS-22) CFSTI: HC $3.00/MF $0.65 CSCL 06M

An overview is presented on the progress being made in developing techniques and instrumentation for spacecraft decontamination. These include: (1) comparison of the standard strip assay procedure with the vacuum probe in recovering *B. subtilis* var. *niger* spores from surfaces of stainless steel fallout strips; (2) exposure of inoculated stainless steel strips in polyethylene tubes sterilized in ethyl oxide or in 2% peracetic acid solution, and the number of microorganisms recovered from the strips; (3) death rate of spore isolates from soil and spacecraft at 125° C; (4) levels of microbial contamination detected on the Apollo command and service modules; and (5) types of aerobic mesophilic microorganisms isolated from the exterior surface of the Apollo 6 command module. M.G.J.

N68-27660# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).
ON THE USE OF THYMINE AND THYMIDINE AS DNA PRECURSORS IN CHLORELLA PYRENOIDOSA [UBER DIE VERWERTUNG VON THYMIN BZW. THYMIDIN ALS DNS-VORSTUFE IN CHLORELLA PYRENOIDOSA]
F. Fetter and H. Altmann 1968 6 p refs In GERMAN
(SGAE-BL-26/1968) CFSTI: HC $3.00/MF $0.65

Investigations were carried out on the incorporation of thymine and thymidine in synchronized chlorella cells during the S-phase. Chlorella contains enzyme systems capable of using both precursors for DNA synthesis, but thymidine is incorporated ten times faster than thymine. Author

N68-27661# Osterreichische Studiengesellschaft fur Atomenergie G.M.B.H., Seibersdorf (Austria).
METABOLISM CHANGES IN YEAST AFTER GAMMA OR BETA IRRADIATION [STOFFWECHSELVERAENDERUNGEN IN HEFE NACH GAMMA-BZW. BETABESTRAHLUNG]
G. Stehlik, H. Altmann, and K. Kaindl 1968 17 p refs In GERMAN
(SGAE-BL-24/1968) CFSTI: HC $3.00/MF $0.65

The survival of yeast cells after beta and gamma irradiations was determined by the capability to form cultures. Only slightly different effects were noted with equal doses. The nucleotide distribution pattern showed greater quantitative changes following gamma irradiation with 300,000 rad than after beta irradiation, but the qualitative composition remained the same. The reduction in the concentrations of nucleoside triphosphates is more pronounced following gamma irradiation than after beta irradiation.
Transl. by K.W.

N68-27739# Osterreichische Studiengesellschaft fur Atomenergie G.M.B.H., Seibersdorf (Austria).
ENERGY TRANSFER STUDIES BY THE SPLITTING OF COPPER FROM COPPER-RIBONUCLEIC-ACID COMPLEXES BY BETA IRRADIATION
L. Kaminski, H. Altmann, R. Heldwein, and K. Kaindl 1968 30 p refs
(SGAE-BL-27/1968) CFSTI: HC $3.00/MF $0.65

A continuous electrophoreses apparatus was used to investigate the splitting of copper from Cu-sRNA complexes. An average G-value of 39.5 ± 4 at an absorbed β-dose of 52.7 rad was obtained. In explaining the splitting mechanism we have tried to interpret the results in the sense of an energy transport within the macromolecule. We have concluded that the copper atoms cause an increase in the resonance energy of the molecular system by their electronic structure and this increase leads to a stronger energy transport capability. Author

N68-27783*# Public Health Service, San Francisco, Calif. Hospital.
A STUDY OF POST-RECUMBENCY ORTHOSTATISM AND PROPHYLACTIC MEASURES FOR PREVENTION OF THIS PHENOMENON, PART 1 Final Report
Kenneth H. Hyatt, William M. Smith, Leonid G. Kamenetsky, and John M. Vogel [1968] 170 p refs
(NASA Order T-28565-G)
(NASA-CR-92178, Pt. 1) CFSTI: HC $3.00/MF $0.65 CSCL 06P

Physiological alterations that result in cardovascular deconditioning was studied on male subjects, ages 21 to 35, using bed rest as an analog to weightlessness. Normal activity was allowed during the first week, when napping was discouraged; and during two weeks of bed rest, the horizontal position was required at all times. Arm movement was limited to forearm raising with the elbows remaining on the bed; and boredom was relieved by reading materials, games, radio, and television. Average systolic and diastolic blood pressure of 20 subjects showed no trend from either bed rest or treatment with 9-alpha-fluorohydrocortisone; weight loss was approximately twice as great during bed rest as during ambulation. Backache, constipation, and headaches were frequent complaints. A 50% incidence of post-recumbency tilt intolerance was noted before and after bed rest. There was no characteristic alteration in pulmonary artery pressure from tilting, and heart rate showed the most obvious and consistent changes. Tilting was generally accompanied by a fall in cardiac output, stroke volume, and central blood volume; and a rise in peripheral and pulmonary vascular resistance and heart rate. M.W.R.

N68-27784*# Public Health Service, San Francisco, Calif. Hospital.
A STUDY OF POST-RECUMBENCY ORTHOSTATISM AND PROPHYLACTIC MEASURES FOR PREVENTION OF THIS PHENOMENON, PART 2. APPENDIX Final Report
Kenneth H. Hyatt, William M. Smith, Leonid G. Kamenetsky, and John M. Vogel [1968] 182 p
(NASA Order T-28565-G)
(NASA-CR-92178, Pt. 2) CFSTI: HC $3.00/MF $0.65 CSCL 06P

Tables detail data obtained during the study of post-recumbency orthostatism in 20 healthy male volunteers subjected to bed rest and 70° tilt. Hemodynamic alterations from passive tilt are shown for the subjects, half of whom were given 9-alpha-fluorohydrocortisone. Other tables indicate brachial artery pulse pressure, hemodynamic response, cardiac output, and central blood volume. In each case comparison is made with and without the drug administration. Other parameters considered include vasomotor wave activity, heart rate variation, oxygen consumption, and fluid balance. Total blood, plasma, and red cell volumes are presented; as are various mineral balances and urine components. Blood chemistries and hematological data are also tabulated.
M.W.R.

N68-27791*# California Univ., Davis. Dept. of Animal Physiology.
PHYSIOLOGICAL LIMITATIONS OF ANIMAL RESTRAINT
E. L. Besch, A. H. Smith, R. R. Burton, and S. J. Sluka [1966] 21 p refs Presented at the 38th Ann. Sci. Meeting Aerospace Med. Assoc., Washington, D. C., 10–13 Apr. 1967
(Grant NGR-05-004-010)
(NASA-CR-83014) CFSTI: HC $3.00/MF $0.65 CSCL 06C

In the development of procedures which will sustain a mature domestic fowl for prolonged periods of time, several types of restraint were investigated. These include (1) rigid support, (2) harness, (3) harness-sling suspension, and a (4) harness cage. Physiological measurements were made, in series, on experimental and control animals for each trial to negate climatic influences. Blood and blood plasma determinations were performed on samples

drawn from the brachial vein, and total white blood cell counts were conducted. Results indicate that the effect of restraint is directly proportional to the duration of exposure. There was a relative and absolute lymphopenia, and relative and absolute rise in heterophils with no changes in the absolute numbers of erythrocytes.
B.S.D.

N68-27816 State Univ. of Iowa, Iowa City.

EFFECTS OF LOCALIZED VIBRATION ON THE HUMAN TACTILE SENSE AS MEASURED WITH A NEW APPARATUS

Harrison Streeter (Ph.D. Thesis) 1967 130 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-9109

The purpose of the study was to determine the effects of vibration frequency, vibration input power, and hand grip strength on tactile sensitivity. A new apparatus was developed and built that delivered short, well-defined bursts of air intermittently against the skin. By controlling the intensity of the air bursts, the subjects were able to determine a minimum, or just detectable, impulse, and so define a threshold of touch in terms of units of pressure. The experiment was devised to investigate effects of frequency and power input at constant grip strength; effects of grip strength and power input at constant frequency; effect of frequency at constant displacement amplitude and constant grip strength; and effect of grip strength alone on the static hand dynamometer. Six subjects were tested under each of 24 different treatment conditions, and the results were evaluated by an analysis of variance. Vibration frequency was found to be a significant variable, with maximum loss in tactile sensitivity being produced by frequencies in the range from 60 to 240 cycles per second (cps). Dissert. Abstr.

N68-27840# Technology, Inc., San Antonio, Tex.

CALCULATION OF RETINAL BURN AND FLASHBLINDNESS SAFE SEPARATION DISTANCES Final Report, Nov. 1966–Oct. 1967

Ralph G. Allen, Jr., Donald J. Isgitt, David E. Jungbauer, James H. Tips, Jr., Patrick W. Wilson, Jr. et al Jan. 1968 156 p refs
(Contract F41609-67-C-0040)
(AD-668549)

Time and wavelength dependent mathematical models for retinal burns and for flashblindness from nuclear detonations are developed in this report. These models are incorporated into a computer program with the latest weapon and burn threshold data to calculate safe separation distances as a function of time for given sets of initial conditions. The results, which present safe separation envelopes with time as a parameter, are included in the appendices. Yield, altitude of detonation, visibility and day or night conditions are also parameters. Retinal burn predictions with this model compare favorably with the experimental results obtained during operation Dominic. Author (TAB)

N68-27875# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Bad Godesberg (West Germany). Institut fuer Flugmedizin.

CONTRIBUTIONS TO SPACE BIOLOGY AND BIOPHYSICS [BEITRAGE ZUR WELTRAUMBIOLOGIE UND BIOPHYSIK]

Wolfgang Briegleb Apr. 1968 96 p refs In GERMAN; ENGLISH summary Meeting of Extraterrest. Biophys. and Biol., Frankfurt am Main, 26–27 Oct. 1966
(DLR-FB-68-24) CFSTI: HC$3.00/MF$0.65

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N68-27876# Federal Aviation Agency, Washington, D. C.

SPACE BIOLOGICAL EXPERIMENTS OF THE GEMINI PROGRAM, AAP (APOLLO APPLICATION PROGRAM) AND APOLLO EXTENSION SYSTEM [BIOLOGISCHE EXPERIMENTE IM RAHMEN DER PROGRAMME GEMINI, AAP (APOLLO APPLICATION PROGRAM) UND APOLLO EXTENSION SYSTEM]

Siegfried J. Gerathewohl *In* DVL Contrib. to Space Biol. and Biophys. Apr. 1968 p 9–24 refs (See N68-27875 16-04)

The author outlines scientific concepts, hypotheses, and assumptions that form the bases for the biological extraterrestrial and biophysical research programs of NASA. Covered are life science experiments during manned space flight missions as well as work in manned orbiting laboratories. Described are biological experiments to investigate weightlessness, ionizing radiation, effects of vacuum, and synergetic effects of space on biological rhythms. Geobiological investigations of plant and animal global distributions, their dependency and transformations caused by geophysical factors are correlated with changes in earth surface properties and biological ecology by global statistics. G.G.

N68-27877# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Bad Godesburg (West Germany) Institut fuer Flugmedizin.

BIOLOGICAL PROBLEMS OF WEIGHTLESSNESS [BIOLOGISCHE PROBLEME DER SCHWERELOSIGKEIT]

Wolfgang Briegleb *In its* Contrib. to Space Biol. and Biophys. Apr. 1968 p 25–48 refs (See N68-27875 16-04)

Physiological weightlessness effects on human and animal organisms are studied by evaluating environmental ecology factors and free fall aspects, as well as results from simulation studies that included prolonged bed rests, acceleration, and submergence. It is shown that the human body is able to adjust to a weightlessness environment; however, the vasomuscular reflex lost part of its ability to adjust readily to normal hydrostatic pressure immediately after gravity is reinstituted. Orthostatic circulatory resistance in humans to zero gravity seemed less affected by real weightlessness situations than in simulated bed rest or submergence studies.
G.G.

N68-27879# Johann-Wolfgang-Goethe-Universitat, Frankfurt am Main (West Germany).

CHEMICAL EVOLUTION AND THE ORIGINS OF THE PREBIOLOGICAL SYSTEM [CHEMISCHE EVOLUTION UND DIE URSPRUENGE PRAEBIOLOGISCHER SYSTEME]

Klaus Dose *In* DVL Contrib. to Space Biol. and Biophys. Apr. 1968 p 57–79 refs (See N68-27875 16-04)

Laboratory experiments show that various chemical energy sources produce amino acids, amines, fatty acids, related heterocyclic compounds, etc. under exposure to reducing atmospheres. A direct formation of polypeptide molecules or related compounds seems only possible in the absence of water vapor. The central function of genetic materials in biological cells indicates that during pre-biological evolution nucleic acids and proteins formed primitive biological structures since regulatory principles of information transmission in biological polypeptide synthesis are supported by a DNS/RNS matrix. Regulatory principles contained in the individual amino acids and in the contact with anorganic environments already exhibit a strong selective preference for definite structures. Transl. by G.G.

N68-27978# Los Alamos Scientific Lab., N. Mex.

POTENTIAL RADIATION HAZARD IN RADAR INSTALLATIONS

H.-J. Koerner [1967] 12 p refs Transl. into ENGLISH from Zentr. Arbeitsmed. Arbeitsschutz (Darmstadt), v. 17, 1967 p 1–5

(LA-TR-68-12) CFSTI: HC $3.00/MF $0.65

High-frequency radiation emitted by the transmitter antenna and ionizing radiation emanating from some tube types used in radar installations are examined. Preventive and monitoring safety measures are discussed. NSA

N68-28004* Pennsylvania State Univ., University Park. Biophysics Dept.

PHYSICS OF CELLULAR SYNTHESIS, GROWTH AND DIVISION Semiannual Report, 1 Jan.–30 Jun. 1968

E. C. Pollard Jul. 1968 11 p refs

(Grant NsG-324)

(NASA-CR-95360) CSCL 06A

An overview is presented on the research findings pertaining to studies on cell structure and DNA degradation, electron spin resonance observations of free radical formation, the ribosome structures of chromatoid bodies, high sugar concentration effects on *E. coli*, electron microscope studies involving phase contrast light microscopy and transmission electron microscopy, the functions of the UAG, UAA, and UGA nonsense codons, microspectrophotometry of red cell ghosts suspended in buffered media, nalidixic acid induction of prophage, and physical properties of irradiated DNA. The most interesting developments are cited as (1) scanning electron microscope observations of the bridges between cells in tissue culture, which may hold the clue to the means by which cells grow together: and (2) the effectiveness of applying Fourier analysis methods to optical diffraction patterns of photographs of ribosomes in regular array. M.G.J.

N68-28037*# San Francisco Univ., Calif. Inst. of Chemical Biology.

BRAIN AMINO ACIDS AND BIOGENIC AMINES UNDER VARIOUS ATMOSPHERIC MIXTURES Semiannual Report, 1 May 1967–31 Jan. 1968

Arthur Furst and H. B. Chermside 10 May 1968 63 p refs

(Grant NGR-05-029-001)

(NASA-CR-95353) CFSTI: HC $3.00/MF $0.65 CSCL 06A

The major objective of this project is the possible effect on brain biochemistry (with emphasis on free amino acid pools) in rodents exposed to artificial atmospheres. After exposure periods of varying lengths in different gaseous compositions, the animals are sacrificed and the free amino acid pools of the animals' brains are measured. An unsuccessful program to develop an analysis for serotonin in one lobe of rats' brains is discussed, and comments on some possibilities for further work on this technique are presented. Evidence to date suggests that the following variables contribute to changes in the amounts of specific amino acids in the brains of rats: (a) the age of the animal; (b) the strain of the animal; (c) exposure to 100% oxygen; and (d) the length of this exposure. Incomplete data indicates that the nature of the "inert" component of a gaseous mixture also affects the amino acid content in the brain. Author

N68-28051*# Chicago Univ., Ill.

ANALYSES OF PYRIMIDINE AND PURINE BASES BY A COMBINATION OF PAPER CHROMATOGRAPHY AND TIME OF FLIGHT MASS SPECTROMETRY

Martin H. Studier (Argonne Natl. Lab.), Ryoichi Hayatsu, and Kiyono Fuse [1967] 11 p refs Supported in part by AEC

(Grant NsG-366)

(NASA-CR-95356) CFSTI: HC $3.00/MF $0.65 CSCL 06A

Described is a promising technique for studying purine and pyrimidine bases by a combination of mass spectrometry and paper chromatography. Mass spectra of numerous bases have been published recently. In general these are characterized by simple spectra with prominent parent ions. Thus, mass spectrometric identification is relatively simple. Author

N68-28053# Florida Univ., Gainesville. Coll. of Medicine.

VISUAL CELLULAR STIMULATION BY HIGH ENERGY QUANTA Technical Progress Report, 1 Dec. 1966–1 Sep. 1967

William W. Dawson Sep. 1967 15 p refs

(Contract AT(40-1)-3599)

(ORO-3599-1) CFSTI: HC $3.00/MF $0.65

Effects of X-rays on the light response of retinal cells in rabbits were investigated. The transduction of X-ray quanta into information transmitted by the optic nerve was studied, as was the identification of retinal cells responsible for the information transmission. NSA

N68-28058*# Techtran Corp., Glen Burnie, Md.

FINGER TIP SKIN TEMPERATURE IN THE MALE AND FEMALE DURING IMMERSION IN COLD WATER

Masatomo Tachi and Hirotoshi Iwata Washington NASA Jun. 1968 6 p refs Transl. into ENGLISH from Igaku to Seibutsugaku (Tokyo), v. 73, no. 4, 10 Oct. 1966 p 193–197

(Contract NASw-1695)

(NASA-TT-F-11790) CFSTI: HC $3.00/MF $0.65 CSCL 06P

A comparative study of healthy male and female digital skin temperatures during immersion in cold water was made as a means of isolating the causes for a 5:1 higher incidence of Raynaud's disease in females than in males. Finger tip skin temperature measurements of the two subject groups were recorded during fifteen minute periods of immersion in water held at temperature levels between 5°C and 30°C, and the following data was obtained: 1) Skin temperature at each water temperature level; 2) Differences between skin and water temperatures; 3) Ratios of skin temperature/water temperature differentials to body temperature/skin temperature differentials. Author

N68-28060# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).

STUDY OF THE RADIATION EFFECTS ON DNA SYNTHESIS IN SYNCHRONOUS CHLORELLA CELLS [UNTERSUCHUNGEN UBER DIE STRAHLENWIRKUNG AUF DIE DNS-SYNTHESE IN SYNCHRONEN CHLORELLAZELLEN]

H. Altmann, F. Fetter, E. Pfisterer, A. V. Szilvinyi, and K. Kaindl 1968 13 p refs In GERMAN

(SGAE-BL-25/1968) CFSTI: HC $3.00/MF $0.65

The variation in the radiation resistance of chlorella cells during their life cycle was investigated for its dependence on the DNA synthesis. The most sensitive stage was observed to occur immediately prior to onset of the DNA synthesis, the resistance increased rapidly during the synthesis phase. The resistance was greatest immediately following completion of the DNA synthesis. Irradiation with 10 krads resulted in a stimulation of the DNA synthesis. Only a small reduction in the DNA synthesis was noted following a dose sufficient to reduce the colony-forming capability by 50%. At 40 krad (LD_{90}), DNA synthesis was strongly inhibited. Possible mechanisms for the variation of radiation sensitivity during the life cycle are discussed. Transl. by K.W.

N68-28064*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.
EFFECT OF THE SPACE FLIGHT FACTORS OF THE FUNCTIONAL STATE OF THE VESTIBULAR ANALYZER. REVIEW OF THE LITERATURE [VLIYANIYE FAKTOROV KOSMICHESKOGO POLETA NA FUNKTSIONAL'NOYA SOSTOYANIYE VESTIBULYARNOGO ANALIZATORA. OBZOR LITERATURY]
Z. I. Apanasenko NASA Jun. 1968 39 p Transl. into ENGLISH from the book "Nekotorye Vopr. Kosmich. Neyrofiziol." Moscow, Izd. AN SSSR, 1967 p 9–44
(Contract NASw-1693)
(NASA-TT-F-11503) CFSTI: HC$3.00/MF$0.65 CSCL 06S

Review of bibliography dealing with the effects of vibration, acceleration, and ionizing radiation on the functions of the vestibular analyzer, covering papers published through 1965. The review shows that the vestibular analyzer is responsible for various disorders in motor coordination and spatial orientation during parabolic and orbital flights and points out a general lack of information on many aspects of the subject. Author

N68-28067# Pittsburgh Univ., Pa. Dept. of Occupational Health.
RADIATION CHEMISTRY AND RADIOBIOLOGY OF MEDIUM EFFECTS Progress Report, 1 Jan.–30 Nov. 1967
30 Nov. 1967 81 p refs
(Contract AT(30-1)-3641)
(NYO-3641-2) CFSTI: HC$3.00/MF$0.65

Culture Media: radiation effects on biological and chemical properties of, γ; Sucrose: radioinduced formation of glyoxal and glyoxylic acid in solutions of, effects of hydrogen peroxide on γ; and Schizomycota: *Salmonella typhimurium*, radiation effects on growth of, effects of hydrogen peroxide and oxygen on γ. NSA

N68-28137 Brown Univ., Providence, R. I.
PERCEPTION OF COLORS DURING VOLUNTARY SACCADIC EYE MOVEMENTS
Victoria Santopietro Lederberg (Ph.D. Thesis) 1966 146 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-2260

The present study investigated the recognition of red, blue, and green stimulus flashes presented in the course of voluntary saccadic eye movements. Several intensities of each stimulus were presented singly to human Ss who was these flashes superimposed on a uniformly bright adaptation field. The results showed that the recognition of the color of red, blue, and green stimulus flashes was best when the flash was presented during steady fixation. The ability to recognize the color of the flash began to decline as the flash was delivered just before the eye began moving, and the suppression continued throughout the movement and for a time after the eye came to rest. The greatest suppression of the recognition of red and green flashes occurred when these stimuli arrived in the middle of a saccade; with blue stimuli, the maximum inhibition occurred 40 msec or 80 msec after the middle. The additional light required for threshold recognition of a color presented during a saccade compared to fixation averaged 0.3 log unit for three Ss. This relatively small amount of inhibition, which occurs even though smearing of the image was virtually eliminated in the experimental arrangements, may be assumed to be mediated by a central inhibitory mechanism. Dissert. Abstr.

N68-28138 California Univ., Berkeley.
SYMMETRY BREAKING CORRECTIONS TO THE COLEMAN–GLASHOW MAGNETIC MOMENT FORMULAE
Thomas Francis Walsh (Ph.D. Thesis) 1966 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 7-8664

We consider the problem: how are the Coleman–Glashow magnetic moment formulae altered by the SU(3) symmetry-breaking? First we consider a simple, essentially perturbation theory, model for the anomalous moments in which the symmetry breaking appears when the physical masses are inserted into the propagators in the amplitude. Following this, we study the commutator of the U-spin raising opertor with the electromagnetic current. In order to find the Σ^* moment in the pole approximation we consider a double commutator involving the I and V spin. From this commutator, in the pole approximation, we find relations formally identical to the Coleman–Glashow ones, except that the anomalous moments K/2m appear. We take up in a provisional way the problem of the continuum corrections to the pole approximation. A simplification is effected because of the appearance of vector currents in the dispersion relation, making it possible to use the Ademollo–Gatto theorem to give the relevant form factors, at least up to first order in the symmetry breaking. The problem of corrections to the pole approximation for the double commutator (and in particular the corrections to the Λ^* moment) is discussed briefly. Dissert. Abstr.

N68-28232# Puerto Rico Nuclear Center, Mayaguez.
ANNUAL REPORT, 1966
Sep. 1967 249 p refs
(Contract AT(40-1)-1833)
(PRNC-102) CFSTI: HC$3.00/MF$0.65

Training programs in health physics, nuclear engineering, and applications of radiation and radioisotopes in the fields of agriculture, biology, chemistry, food processing, and medicine are described. Brief summaries of results of research studies are presented. A list is included of 70 papers published during the period covered by this report. NSA

N68-28246*# National Aeronautics and Space Administration, Washington, D. C.
AEROSPACE MEDICINE AND BIOLOGY—A CONTINUING BIBLIOGRAPHY WITH INDEXES, MAY 1968
Jun. 1968 174 p refs
(NASA-SP-7011(51)) CFSTI: HC$3.00/MF$0.65 CSCL 06S

Subject coverage concentrates on the biological, physiological, pyschological, and environmental effects to which man is subjected during and following simulated or actual flight in the earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Each entry consists of a standard citation accompanied by its abstract. Author

N68-28247*# Litton Systems, Inc., Minneapolis, Minn.
MICROBIOLOGICAL EXPLORATION OF THE STRATOSPHERE. DEVELOPMENT AND FLIGHTS OF THE MARK 2 AND 3 SAMPLING SYSTEMS
Paul D. Pederson, Jr. Washington NASA Jun. 1968 139 p refs
(Contract NAS5-3888)
(NASA-CR-1101; TR-3172) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Research to determine the existence and identity of viable microorganisms in the stratosphere was performed. This report covers all effort expended and includes the description of two sampling systems (Mark II and Mark III) which employ low-pressure drop media for the collection of viable microorganisms at low air densities. A total of seven operationally successful flights were conducted with samples obtained from altitude profiles ranging from 10,000 to 90,000 feet. Emphasis was on contamination control techniques to minimize or eliminate microbial background during all procedures associated with sample acquisition and analysis. Organisms recovered existed in low numbers generally varying inversely with altitude in the range of 10^{-2} to 10^{-4} organisms per ambient ft^3 air. A variety of bacterial and fungal species were isolated. Author

N68-28278*# Esso Research and Engineering Co., Linden, N. J.
STUDY OF METHODS FOR CHEMICAL SYNTHESIS OF EDIBLE FATTY ACIDS AND LIPIDS Final Technical Report
John W. Frankenfeld, ed. Washington NASA Jul. 1968 160 p refs
(Contract NAS2-3708)
(NASA-CR-1105) CFSTI: HC$3.00/MF$0.65 CSCL 06A

A survey and critical evaluation of existing methods for the synthesis of fatty acids and lipids from metabolic wastes under conditions of space travel was completed. An extensive literature search was conducted and the candidate processes were evaluated from the standpoints of chemical feasibility and nutritional value of the products. The only promising route involved synthesis of ethylene from carbon monoxide, polymerization to α-olefins *via* the Ziegler growth reaction, conversion to fatty acids by oxidative ozonolysis and combination with glycerol to form edible glycerides. Four methods for the synthesis of glycerol were discovered. The most promising are base catalyzed trimerization of formaldehyde followed by hydrogenation and hydrogenolysis of higher sugars which may be prepared by controlled polymerization of formaldehyde. The synthesis of glycerol is much less complicated than fatty acid production and hence is a recommended alternate. A series of recommendations for further research and development were drawn up. These are mostly in the area of engineering and nutrition. Author

N68-28283*# Scripta Technica, Washington, D. C.
EFFECTS OF THE LABYRINTHS ON THE CERVICAL MUSCLE TONUS [K VOPROSU O VLIYANII LABIRINTOV NA TONUS SHEYNYKH MYSHTS]
S. I. Stepanova NASA May 1968 9 p refs Transl. into ENGLISH from the book "Vopr. Aviats. Med., Normal'n. i Patologicheskoy Fiziol." Moscow, Tsentr. Inst. Usoversh. Vrachey Press, 1966 p 120–129
(Contract NASw-1694)
(NASA-TT-F-11615) CFSTI: HC$3.00/MF$0.65 CSCL 06A

It is demonstrated that the electromyographic tonus of the sternocleidomastoid muscles of intact rabbits is equally strong on both sides and that it weakens considerably on the operated side and remains essentially unaffected on the intact side after uniliteral labyrinthectomy. Author

N68-28332 Kent State Univ., Ohio.
THE KINETICS OF THE OXIDATION OF SEC-BUTYLBENZENE IN A BASIC EMULSION BY MOLECULAR OXYGEN
William Robert Burg (Ph.D. Thesis) 1964 125 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-9820

The rates of reaction of sec-butylbenzene with oxygen at different initiator concentrations in a basic oil-in-water emulsion have been measured. The stereochemical course of the reaction was established by the oxidation of sec-butyl-benzene to give a racemic mixture of 2-butyl-2-phenyl hydroperoxide. The rate determining step was shown, by the deuterium isotope effect in the oxidation of sec-butylbenzene-d_α to be the abstraction of an α hydrogen. The k_H/k_D ratio was found to be 3.2. The overall activation energy was calculated as 12.3 kcal. The characteristics of the oxidation reaction are consistent with a radical-chain mechanism. Dissert. Abstr.

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N68-26965*# University of Southern Calif., Los Angeles.
THE EFFECT OF A RANDOM SAMPLING INTERVAL ON A SAMPLED-DATA MODEL OF THE HUMAN OPERATOR
G. A. Bekey, J. M. Biddle, and A. J. Jacobson (Hughes Aircraft Co., Culver City, Calif.) [1967] 15 p ref Presented at the USC-NASA Conf. on Manual Control, Los Angeles, 1–3 Mar. 1967
(Grant NGR-05-018-022)
(NASA-CR-87263) CFSTI: HC$3.00/MF$0.65 CSCL 05H

A sampled-data human operator model in which the sampling interval varied randomly about some mean value is studied by analog computer simulation in a one dimensional tracking loop with constant gain. The model input consists of the sum of five essentially non-harmonic sine waves and a power spectral analysis is performed on the model output. Experimental results show that it might be possible to determine the presence of an internal sampler by examining the human operator's output spectra if a random sampler with reasonable amount of randomness is assumed. G.G.

N68-26997# School of Aerospace Medicine, Brooks AFB, Tex.
TRENDS IN AIRCREW ATTITUDES AND JOB SATISFACTION
George K. Cantrell and Bryce O. Hartman Feb. 1968 33 p refs Submitted for publication
(SAM-TR-68-19; AD-669075)

The Military Airlift Command annual aircrew management review forms were completed by four groups of line aircrewmen: (1) the first officer group (N-500); (2) the first airman group (N-500), whose data were collected during the same approximate time period as were those of the first officer group; (3) the second officer group (N-492), whose data were collected subsequent to those of the first officer group; and (4) the second airman group (N-144), whose data were collected during the same approximate time period as were those of the second officer group. Data from the second groups were compared with those from the first groups to reveal the presence, direction, and magnitude of any potential trends--positive or negative--in the problem areas represented by the survey items. This comparison revealed that, for the officer aircrewmen, the largest negative change was an increased tendency to want to resign from the service, while three factors were tied in showing the largest positive change. These three factors were an increase in satisfaction with the hours flown each month, an improvement in the probability of actually getting planned days off, and a higher level of job-satisfaction. For the airmen, equal negative changes occurred in their feelings toward their duty assignment and in how they felt on their days off, while the largest positive change was in the probability of actually getting planned days off. Author (TAB)

N68-27046# Northrop Corp., Hawthorne, Calif.
VARIABLE THERMAL CONDUCTIVITY HEAT TRANSFER RESEARCH FOR PERSONAL PROTECTIVE ASSEMBLIES Final Report, 1 Jun. 1966–31 Aug. 1967
Robert B. Olson, John W. Felder, and Charles F. Lombard Wright-Patterson AFB, Ohio Aerospace Med. Res. Labs. Dec. 1967 52 p refs
(Contract AF 33(615)-5109)
(NCL-67-36R; AMRL-TR-67-190; AD-668765)

In this program a feasibility study was conducted of a conductive cooling system for cooling a man in space. In the concept studied the cooling was provided by a porous plate sublimator and controlled by a variable thermal conductance layer. The results of the tests performed demonstrate the need for advances in technology and further development work to make this concept feasible.
Author (TAB)

N68-27110# Naval Submarine Medical Center, Groton, Conn.

PROPOSED AUDITORY DAMAGE RISK CRITERIA FOR THE NAVY

J. Donald Harris 30 Jan. 1968 15 p refs
(Rept.-68-2; AD-668703)

The results of the latest thinking of several nationally recognized groups on the problem of noise exposure and hearing loss have been summarized into four tables. Auditory Damage Risk Criteria in the form of permissible Sound Pressure Levels are provided for pure tones, steady-state noises, and intermittent noises, for a selection of minutes-exposure during a typical working day. The criteria are limited to the frequency regions 500-2000 cycles per second.
Author (TAB)

N68-27156*# Alabama Univ. Research Inst., Huntsville. Dept. of Engineering Mechanics.

DYNAMICS OF THE ORBITAL CENTRIFUGE

R. R. Reed [1967] 22 p refs Presented at Am. Astronautical Soc. Natl. Symp. on Saturn 5, Apollo and Beyond, Huntsville, Ala., Jun. 1967
(Grant NsG-381)
(NASA-CR-85177) CFSTI: HC $3.00/MF $0.65 CSCL 05E

The problems associated with the active control of the attitude of an orbiting space vehicle become more critical as the duration of the mission increases. A passive control system, therefore, becomes more important, as the weight penalities occurred by active systems are prohibitive. The simplest passive system is one where no attempt is made to control the attitude, but the spacecraft is designed to minimize adverse attitude deviations. This passive control can be difficult when disturbing torques are present due to internal or external moving parts such as the movements of man. Coupled with this control problem is the problem of designing a centrifuge to study and control the effects of weightlessness on man. In these studies a wide range of artificial gravity loads are required and some must be obtained with considerable accuracy. Therefore, the attitude deviations of the vehicle must be determined quite accurately to establish the appropriate g loads for studies on weightlessness. Furthermore, the disturbing torque due to the movement of the man and centrifuge requires an investigation of different designs to minimize or utilize the induced vehicle motion.
Author

N68-27160*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

INFORMATION-PROCESSING RATE AS INFLUENCED BY THE DEGREE OF RESPONSE DIFFICULTY: A DISCRETE TRACKING TASK

Daniel L. Baty [1967] 23 p refs Presented at the Manual Control Conf., Los Angeles, 1-3 Mar. 1967
(NASA-TM-X-59802) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The degree of task difficulty was quantified for a series of discrete, random-input tracking tasks. Performance on one-dimensional (1-D) and two-dimensional (2-D) tasks was compared at equal values of task difficulty. Fourteen tasks were used, 9 with 4 target alternatives, and 5 with 16 target alternatives. Six subjects performed the self-paced tasks by rapidly touching with a stylus well-defined areas as they were successively illuminated in a random sequence. Performance in terms of the information-processing rate was primarily determined by the degree of response difficulty and the number of target alternatives. Performance in terms of the average time per response, however, was determined primarily by the degree of response difficulty. For this type of task, higher information-processing rates are possible for 2-D tasks than for 1-D tasks because, for a given number of stimulus alternatives and a constant target size, the 2-D grouping has the lower value of task difficulty.
Author

N68-27201*# LTV Aerospace Corp., Dallas, Tex. Astronautics Div.

AMU TRAINING SIMULATION PROGRAM

H. E. Sewell, Jr. 27 Apr. 1966 41 p
(Contract NAS9-5711)
(NASA-CR-92163; Rept.-00.794) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A simulation program in the LTV Astronautics Manned Aerospace Flight Simulator (MAFS) was used to provide training of the GT-9 primary and backup pilots in the operation and handling qualities of the LTV Astronaut Maneuvering Unit (AMU). The simulation program was operated for a period of two weeks, including the NASA engineering review phases, with a total of over 100 simulated runs being performed. The program involved the performance of various maneuvers with the AMU rotations and translations relative to both simulated Gemini and Agena spacecraft. Control of the AMU was evaluated in both the automatic and manual attitude modes with various failure modes. Several guidance techniques for effecting transfers, translations, to the spacecraft were investigated. A technique for the gross transfer maneuver which involved establishing a closure rate and then yawing the AMU such that the thruster alignment relative to the line of sight provided two-dimensional translational control of line of sight rotation proved to be most promising. The simulation utilized the MAFS moving base simulator and a hybrid, digital-analog computer arrangement.
Author

N68-27222 Pennsylvania Univ., Philadelphia.

AUDITORY FREQUENCY DISCRIMINATION

Gordon Bruce Henning (Ph.D. Thesis) 1966 80 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-7841

The principal topic of the thesis is frequency discrimination. The first important variable considered is the ratio of signal energy to noise-power density. Frequency discrimination performance is found to increase with increasing ratio of signal energy to noise-power density when that ratio is small. Once the ratio of signal energy to noise-power density exceeds approximately 40 dB, however, discrimination performance is no longer influenced by the signal-to-noise ratio. The second important variable is the effect of frequency on frequency discrimination. It was possible that, at high frequencies, observers in classical frequency discrimination studies had been detecting amplitude rather than frequency differences. The effect of the random amplitude tones was negligible at 1000 cps but bery large above 3000 cps. The measured effect of frequency on frequency discrimination obtained when random amplitude tones are used is quite different from the classical results in the frequency range above 3000 cps and, we suggest, reflect more accurately the frequency discrimination capability of human observers at high frequencies.
Dissert. Abstr.

N68-27325# Atlantic Fleet, Norfolk, Va. Antisubmarine Warfare Force.

COMPUTER (1401) PROGRAM DOCUMENTATION FOR BEHAVIORAL TASKS

John A. Mc Laurin Apr. 1968 189 p refs *Its* Working Paper 101827.100
(AD-668968)

The paper is designed to be informative at different levels: (1) The Functional Description reflects the initial analysis of the system and defines the operational capability to be developed without going into the details of each individual operation. (2) The Data Requirements Document defines the data elements used within the system. (3) The System Specification is a more detailed documentation of the entire system. (4) The Program Specification describes program design so as to permit program production. Each program within the system is defined in a separate Program Specification and only information pertaining to that program and how it relates to other operations within the system is presented in these sections. Program listings are included in this section. (5) The Operations Manual documents the operating procedures necessary to operate each function within this system. Instructions are given for initiating, running, terminating, interrupting and restarting each function within the system. Author (TAB)

N68-27337# Aberdeen Proving Ground, Md. Human Engineering Labs.

RADAR SYMBOLOGY STUDIES LEADING TO STANDARIZATION

C. Jane Davis Feb. 1968 53 p refs
(TM-5-68; AD-668649)

The report covers initial studies directed toward standardization of basic symbols representing enemy, friendly, and unknown targets on a radar scope. College students of both sexes and enlisted military men served as subjects. In Experiment I, subjects assigned and ranked 68 geometric designs within the three meaning categories. Experiment II studied retention values after a short exposure to these same forms. Experiment III required all subjects to design a code differentiating the three meaning categories. All significant findings on meaning were highly dependent on pictorials. Perceptual differentiation and ease of learning are recommended as the major dimensions of code design. Author (TAB)

N68-27408*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ATMOSPHERIC-CONTROL SYSTEMS FOR EXTENDED-DURATION MANNED SPACE FLIGHT

Dan C. Popma [1967] 24 p refs Presented at the Conf. on Bioastronautics, Blacksburg, 14–18 Aug. 1967
(NASA-TM-X-60423) CFSTI: HC$3.00/MF$0.65 CSCL 05K

An overall view of candidate processes for atmospheric control systems is presented, and the factors which influence selection, power penalty, mission goal, and mission duration are indicated. The humidity control systems discussed are a technique using a cooled sintered metal plate and a technique using hydrophobic and hydrophilic surfaces. Methods of removing carbon dioxide include molecular sieves, carbonation cell, and absorbing resins, and emphasis is placed on the approaches using molecular sieves. The oxygen reclamation systems incorporating Sabatier and Bosch reactions, solid electrolytes, and molten carbonate are compared. Mention is also made of the influence of a zero g environment on these operations, and of the long-term reliability of the systems. N.E.N.

N68-27415# Purdue Univ., Lafayette, Ind.

AN IMPLICATION FOR THE INFORMATION SEARCH CONCEPT: EFFECTS OF INCREASING SUCCESS AND FAILURE ON PERCEIVED INFORMATION QUALITY

Siegfried Streufert and Carl H. Castore (Rutgers Univ.) Feb. 1968 15 p refs
(Contract N00014-67-A-0226-0007)
(TR-9; AD-668529)

The effect of experimentally-induced success and failure in a complex decision-making task on subjective estimates of information quality was obtained for information relevant to subjects' own decision-making area and that of a marginal group member. It was found that quality initially is perceived to improve. Estimates of quality for success and failure conditions do not differ until success and failure levels are quite high. Once high levels of success are reached, subjects in the success condition consider information as further improving, while subjects in failure conditions maintain previous perceptions. The implications of this result for complexity theory are considered. The relationship of the results to work on information search and information utilization is explored. Some suggestions for practical applications of the research results are made. Author (TAB)

N68-27428* Georgia Univ., Athens. Inst. of Ecology.

THE CASE FOR THE MULTI-SPECIES ECOLOGICAL SYSTEM, WITH SPECIAL REFERENCE TO SUCCESSION AND STABILITY

G. Dennis Cooke, Robert J. Beyers, and Eugene P. Odum [1967] 26 p refs Presented at NASA Conf. on Bioregenerative Systems
(Grant NsG-706; Contract AT(38-1)-310)
(NASA-CR-83489) CFSTI: $3.00 CSCL 06K

An evaluation of proposed life support systems based on ecological theory is presented. The two organism life support system is compared with a multi-species life support system as to stability, structure, and energy flow. It is concluded that the multi-species system is ecologically more sound. This position is supported with data taken from laboratory microecosystems. Author

N68-27434*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FLIGHT SIMULATION AND PILOT DESCRIBING FUNCTION TECHNIQUES APPLIED TO THE ANALYSIS OF A PILOT CONTROL SYSTEM FOR A LARGE FLEXIBLE LAUNCH VEHICLE

Brent Y. Creer, Gordon H. Hardy, and Dallas G. Denery Washington [1966] 35 p refs Presented at the Symp. on the Human Operator in Aircraft and Spacecraft Control of AGARD, Paris, 5–6 Sep. 1966
(NASA-TM-X-59113) CFSTI: HC$3.00/MF$0.65 CSCL 05H

The NASA has completed two phases of a general piloted launch vehicle study. The first phase studied the feasibility of using a pilot to guide and control a vehicle from earth lift-off through insertion into earth orbit. Two different study methods were used. One method was primarily a paper and pencil study, based on servo-analysis theory, wherein a mathematical model was used to describe pilot behavior. The other approach used simulators extensively. The first part of this paper discusses the relative adequacy of these methods. It was concluded that much can be learned by analytical procedures alone, but that assuming a linear pilot model has its pitfalls. In the second phase of the study, a ground-based flight simulator was used to measure the contribution to mission reliability of allowing the crew to participate actively in guiding and controlling the vehicle if certain primary flight control systems fail. The second part of this paper discusses the methods used in this reliability analysis. It was concluded that this procedure can systematically determine mission success for complex manual control problems. Author

N68-27532*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A PROGRAMABLE DISPLAY SYNTHESIZING SYSTEM FOR MAN MACHINE COMMUNICATIONS RESEARCH

Jack J. Hatfield [1967] 20 p refs Presented at the 7th Natl. Symp. on Inform. Display, Boston, 18–20 Oct. 1966
(NASA-TM-X-59971) CFSTI: HC$3.00/MF$0.65 CSCL 05H

This paper includes a description of the display system configuration with regard to major components required to achieve electronic animation. Major subsystems described include a stored program control unit and a digitally controlled vidicon film scanner, flying spot film scanner, and scan converter. Programing technqiues and system operational modes are discussed from the viewpoint of relating how dynamic and static display patterns are called up from random access film storage, how individual dynamic patterns are electronically modified, written into transient storage, and updated to convey motion, and how dynamic and static portions of the display are combined to form animated composites. Examples of synthesized flight displays are exhibited. System performance is discussed and compared with that of conventional computer-CRT stylized displays. The advantages of electronic animation with regard to format change, program complexity, regeneration rates, and image characteristics for certain classes of displays are presented. Author

N68-27534*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A SURVEY OF SELECTED RESEARCH ON HUMAN CONTROLLER CHARACTERISTICS

Melvin Sadoff Washington [1966] 48 p refs Presented at the Symp. on the Human Operator in Aircraft and Spacecraft Control of AGARD, Paris, 5–6 Sep. 1966
(NASA-TM-X-59083) CFSTI: HC$3.00/MF$0.65 CSCL 05H

A survey of research on human-operator characteristics is presented. Particular emphasis is placed on the progress in developing human-operator models for manual control tasks of increasing complexity and on the effects of acceleration stress on describing-function models. The results reviewed indicate that quasi-linear models for single-loop manual control systems were developed to a sufficient degree of precision and refinement for many manual control situations. Examples of the utility of relatively crude pilot modesl in several pilot-vehcile systems analysis and design problems are described. However, results for more complex control tasks indicate that pilot models for these control situations are fairly primitive and require additional research. Relatively meager results of tests conducted under high sustained accelerations, vibration, and short-term weightlessness indicate these environments can result in marked changes in pilot describing-function models and in pilot performance. Some remarks are presented in the final section of the paper on some limitations and deficiencies of human-operator models and on the direction of current research on human controller characteristics. Author

N68-27616*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A KINEMATIC STUDY OF THE EFFECTS OF REDUCED GRAVITY ON SELF-LOCOMOTION

Amos A. Spady, Jr. [1966] 10 p refs Presented at the 1966 ASME Winter Ann. Meeting, New York, 27 Nov.–1 Dec. 1966
(NASA-TM-X-59569) CFSTI: HC$3.00/MF$0.65 CSCL 05H

Measurements of gait characteristics point out that man's self-locomotive performance will be enhanced in lunar gravity. His optimum speed may be increased, he will be able to jump higher and further, and carry much heavier loads than his earth counterpart. Author

N68-27650*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

GASEOUS MONITORING FOR THE INTEGRATED LIFE SUPPORT SYSTEM AT LANGLEY RESEARCH CENTER

Thomas O. Wilson and E. E. Mason [1967] 17 p refs Presented at the 3d Ann. Conf. on Atmospheric Contamination in Confined Spaces, Dayton, Ohio, 9–11 May 1967
(NASA-TM-X-59827) CFSTI: HC$3.00/MF$0.65 CSCL 06K

Analytic equipment and procedures, sampling techniques, and support activities are discussed as they relate to the evolution of the gas monitoring system. A general purpose thermal conductivity detector, process gas chromatograph was used to monitor various stages of gas processing in the oxygen reclamation subsystem and the gaseous environment. A Karman detector gas chromatograph was modified for use as a trace contaminant detector and for trace analysis when used in conjunction with the process chromatograph. The unexpected problems encountered in the construction of instrumentation are also discussed. A transfer or patchpanel was designed as an interconnecting link between the test bed and the atmospheric monitoring areas to simplify sample stream selection and delivery to the analytical equipment, cryogenic sampling system, and the wet chemistry area. It is pointed out that the problems of sampling and sample handling must be solved before the instrumentation can truly be effective in contaminant definition. Results of the tests reveal that the nonadapted nose is still the most sensitive detector for odoriferous compounds in small quantities. A.L.

N68-27700# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.

THE USE OF THE COULTER COUNTER IN THE ANALYSIS OF BACTERIAL CULTURES [L'IMPIEGO DEL COULTER COUNTER PER L'ANALISI DI COLTURE BATTERICHE]

M. Belli 28 Nov. 1967 49 p refs In ITALIAN; ENGLISH summary Sponsored by Consiglio Nazl. Delle Ric.
(ISS-67/43) CFSTI: HC$3.00/MF$0.65

The Coulter Counter is a new electronic analyzer designed to obtain volume spectra for particles in suspension in the range 0.25-300μ^3. In this report its use in the analysis of bacterial cultures in liquid medium is described and some remarkable advantages over usual techniques are pointed out. The device is described in detail; its characteristics are examined and a standardization for bacterial cells is proposed. Finally, some results from spectrum analysis of liquid cultures of "*E. coli* BB" cells in various phases of their growth curve are presented, in which a significant decrease of the most frequent cell volume apparent during the transition from exponential to stationary phase. Author

N68-27794*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE EFFECTS OF THE PLANE OF VESTIBULAR STIMULATION ON TASK PERFORMANCE AND INVOLUNTARY EYE MOTION

William Letko and Ralph W. Stone, Jr. [1967] 22 p refs Presented at the Symp. on the Role of the Vestibular Organs in the Exploration of Space, Pensacola, Fla., 24–27 Jan. 1967
(NASA-TM-X-59523) CFSTI: HC$3.00/MF$0.65 CSCL 05H

An overview is presented on the differences found in experiments conducted to determine the relationship between the orientation of the astronaut within a rotating space vehicle simulator and the influence which it exerts on the stimulation of his vestibular system. The physical stimulation that occurs because of axial orientation or tangential orientation are compared in terms of three angular accelerations of the head as functions of head position and vehicle angular velocity. Details are given on experiments performed with the subject facing tangentially. Results indicate that for a turning head motion, the stimulation experienced by the tangentially oriented subjects is considerably different than that experienced by the axially oriented subjects, the stimulation being a cross-coupled acceleration in the nodding sense when tangentially oriented and in the rolling sense when axially oriented. A tolerance to 10 rpm is generally indicated for most subjects. The data also show that the subjects could tolerate greater cross-coupled accelerations when facing tangentially than they could while facing axially. B.S.D.

N68-27876# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Bad Godesberg (West Germany). Institut fuer Flugmedizin.

CROSS STRESS BETWEEN BODY TRAINING AND TOLERANCE TO HEIGHTS [GEKREUZTE ANPASSUNG ZWISCHEN KOERPERLICHEM TRAINING UND HOEHENTOLERANZ]

Ernst D. Voigt *In its* Contrib. to Space Biol. and Biophys. Apr. 1968 p 49–56 refs (See N68-27875 16-04)

Adaptive adrenal cortex responses in man to environmental stress, exercise, and acceleration showed a fast and relatively long lasting output increase. At high altitudes, the ATP level of athletes was generally higher than in untrained persons regardless of rest and activity periods. Transl. by G.G.

N68-28003*# Stanford Univ., Calif. Div. of Engineering Mechanics.

REORIENTATION OF THE HUMAN BODY BY MEANS OF ARM MOTIONS

C. Riddle and T. R. Kane Feb. 1968 65 p
(Grant NGR-05-020-209)
(NASA-CR-95362; TR-182) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Consideration is given to the determination of changes in orientation of the human body in a state of free fall (weightlessness), with the changes resulting from specified motions of the arms relative to the remainder of the body. A computer program, written in Fortran 4 for the IBM 360/67, is documented, and examples in the use of the program are given. Author

N68-28057*# Techtran Corp., Glen Burnie, Md.

HUMAN ABILITY TO WORK UNDER DECREASED AIR PRESSURE [DIE ARBEITSFAHIGKEIT DES MENSCHEN BEI VERMINDERTEM LUFTDRUCK]

R. Margaria Washington NASA Jun. 1968 11 p refs Transl. into ENGLISH from Arbeitsphysiol., v. 2, 1930 p 261–272
(Contract NASw-1695)
(NASA-TT-F-11774) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Laboratory tests were carried out under decreased atmospheric pressures. Test subjects worked at their own rates on a cycle ergometer which partially actuated a generator; the square of the amperage difference was used as a measure, converted into kilogram meters per second. Pressure as at 5000 meters prevented 3 out of 4 subjects from accomplishing his set goal of 10 minutes work. Only one was able to complete a test at 7000 meters. Work in these high atmospheres led to euphoria; lack of motor, perception and memory abilities; fainting conditions. Mimetic muscular fibrillation and spastic contraction of other muscle groups was generally noted. Respiration remained regular and deep, though slow. Anoxemia works first on the muscles and then on the central nervous system. Author

N68-28157*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

CHANGES IN PERCEIVED SIZE AND SHAPE OF A HIGHLY LUMINOUS TARGET

Richard F. Haines [1966] 15 p refs Presented at the Joint Meeting of the Opt. Soc. of Am., The Am. Chem. Soc., and the Soc. for Appl. Spectry., San Francisco, 17–21 Oct. 1966
(NASA-TM-X-59084) CFSTI: HC $3.00/MF $0.65 CSCL 05J

The quantification of perceived changes in size and shape of a very bright target and the relation to associated stimuli are studied. A small, very bright target foveally fixated against an unilluminated background appears larger and rounder. This expansion in size (irradiation) is explained as being at least in part due to involuntary ocular motions causing the target's retinal image to light-adapt a larger number of retinal receptors. It is suggested that the magnitude of irradiation is not related to target luminance as much as to the magnitude of the target's retinal image motion, with the two possibly interacting. If assuming that observer fixation occurs along a radial pattern originating at the center of the target, with relatively constant sweep magnitude, the results of this study can be explained. A second hypothesis suggests that the rounded target appearance results from a diffraction effect at the pupil. K.W.

N68-28319*# IIT Research Inst., Chicago, Ill.

PRELIMINARY STUDY OF ADVANCED LIFE-SUPPORT TECHNOLOGY FOR A MARS SURFACE MODULE

R. E. Mitchell and M. Burns Washington NASA Jun. 1968 189 p refs
(Contract NASr-65(15))
(NASA-CR-1083) CFSTI: HC $3.00/MF $0.65 CSCL 06K

This study represents an initial step in the direction of subsystem definition for extended manned missions on Mars and is centered primarily around a review of the current literature and state-of-the-art techniques. A mission profile of four men for six months is analyzed. From this baseline assumption, a Mars surface module configuration is projected, and subsystems in life support, power, and environmental control most candidate for the proposed mission are assessed. Author

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N68-26988# Weizmann Inst. of Science, Rehovoth (Israel). Polymer Dept.

MECHANOCHEMISTRY OF COUPLED CONTRACTILE AND CHEMICAL RATE PROCESSES Final Report, 1 Jan. 1966–31 Dec. 1967

A. Katchalsky 31 Dec. 1967 119 p refs
(Contract AF 61(052)-919)
(AFOSR-68-0797; AD-668557)

Contents: introductory review; a dynamic-elastic investigation of the chemical denaturation of collagen fibers; the mechanochemical melting of collagen fibers (Part I, mechanical contractions); the mechanochemical melting of collagen fibers (Part II, diffusion controlled contractions); contraction-relaxation of collagen fibers in LiBr-water-acetone solutions; study of collagen denaturation kinetics by dynamic mechanical methods. Author (TAB)

N68-27016# Mound Lab., Miamisburg, Ohio.

THE REACTION BETWEEN EPOXIDES AND BOROXINES

M. S. Matta 28 Feb. 1968 17 p refs
(Contract AT-33-1-GEN-53)
(MLM-1440) CFSTI: HC $3.00/MF $0.65

The reactions of epoxides with trialkyl and trialkoxy boroxines of varied substitution were studied to clarify the foam producing reaction of trimethoxyboroxine with vinyl cyclohexene dioxide. Epoxides whose oxirane ring open to secondary carbonium ions formed only polymeric products, and those which open to tertiary or benzylic carbonium ions formed mixtures of polymerization and isomerization products. A thorough examination of the products of reactions employing epoxides and boroxines of varying molecular structure provided information on the pathway by which Lewis acids promote epoxide polymerization. Also, the role of boroxines as Lewis acid catalysts was investigated. No attempt was made to acquire quantitative data because the purpose of these experiments was exploratory. Author (NSA)

N68-27020# Los Alamos Scientific Lab., N. Mex.

REACTION KINETICS IN CONCENTRATION SPACE

C. J. Everett 15 Mar. 1968 17 p refs
(Contract W-7405-ENG-36)
(LA-3875) CFSTI: HC $3.00/MF $0.65

A "global" view of a reversible reaction governed by the law of mass action is obtained by regarding all its possible histories as trajectories in a space of concentrations. Processes at constant volume and pressure are studied in some detail. The picture obtained is one of a space separated into two components by a hypersurface of equilibrium points, toward which all points of these components flow, on a family of trajectories simply covering the space. NSA

N68-27072# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.

ASP: ANALYSIS OF SYNTHETICS PROGRAM FOR QUALITY CONTROL DATA

L. V. Bailey and L. M. Arnett Jan. 1968 15 p
(Contract AT(07-2)-1)
(DP-1127) CFSTI: HC$3.00/MF$0.65

The computer program, ASP, which calculates bias, precision, and other statistics of analytical methods, was written in FORTRAN 4 for use on the IBM System/360-65. The Savannah River Plant laboratories use ASP monthly and quarterly to evaluate and to report the bias and precision of analyses important to process control and accountability. Author (NSA)

N68-27101 Cornell Univ., Ithaca, N. Y.

GROUP 4—OXYGEN HETEROCYCLES

Carolyn Majorie Silcox Yoder (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-1444

This study was undertaken to investigate the chemistry of organic heterocycles having an O-M-O linkage where M is a group 4 element. A literature search indicates the recent work in this area. Until the 1950s and 60s most compounds containing the O-M-O link were silicates. Ring structures having the O-M-O linkage in cyclic structures with two carbon atoms of an aromatic ring and with four carbon atoms of an aromatic system are known. An investigation of the six-membered ring structure containing the *peri*-naphthalene system bonded to O-M-O, another new cyclic arrangement in group 4 organometallic chemistry, is presented. Bis-(1,8-naphthalenedioxy)silane and germane, (1,8-naphthalenedioxy)dimethyl-and-diphenylsilane have been prepared *via* an esterification reaction between the dihydric phenol, 1,8-dihydroxynaphthane, the tetrachlorosilane and germane or the appropriate diorganodichlorosilane. An improved method for obtaining 1,8-dihydroxynaphthalene is included as well as a comparison of the properties of analogous compounds of the homologous series, *o*-phenylenedioxy, 1,6-naphthalenedioxy and 2,2'-diphenylenedioxy. Dissert. Abstr.

N68-27111# TRW Systems, Redondo Beach, Calif. Chemical Sciences Dept.

LASER PHOTOLYSIS AND SPECTROSCOPY: A NEW TECHNIQUE FOR THE STUDY OF RAPID REACTIONS IN THE NANOSECOND TIME RANGE Technical Paper, 15 Jun. 1967–15 Mar. 1968

J. R. Novak and M. W. Windsor 3 Apr. 1968 37 p refs
Submitted for publication
(Contract N00014-67-C-0327)
(TRW-05824-6006-R000; AD-668987)

A new, very rapid, spectroscopic recording technique was developed with which photographic absorption spectra of transient intermediates with nanosecond lifetimes can be obtained. The technique is a hundred times faster than present flash spectrographic instrumentation and provides time-resolved absorption spectra over a wide spectral range in a single experiment. The laser photolysis technique was applied to observing, for the first time, absorption spectra arising from the lowest excited singlet states of several aromatic hydrocarbons. Time-resolved spectra show the decay of the new absorption bands and the concomitant buildup of triplet-triplet absorption bands during the first microsecond following light absorption. TAB

N68-27171*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SYNTHESIS AND THERMAL STABILITY OF BENZIMIDAZOLE AROMATIC IMIDE COPOLYMERS

Toshikazu Kurosaki and Philip R. Young [1966] 24 p refs
Presented at the IUPAC Intern. Symp. on Macromol. Chem., Tokyo–Kyoto, Japan, 28 Sep.–4 Oct. 1966
(NASA-TM-X-59061) CFSTI: HC$3.00/MF$0.65 CSCL 07C

Polybenzimidazoles and aromatic polyimides are well known for their high thermal stability. Recently Iwakura tried to prepare thermally stable benzimidazole-amide copolymers from 2,2'-amino-phenyl-5,5'-dibenzimidazole and dicarboxylic acid dichlorides. The approach in this laboratory was to synthesize benzimidazole-aromatic imide copolymers from diamino-phenylbenzimidazoles and aromatic dianhydrides. This approach established that by choosing appropriate polymerization methods and curing processes, polymer films of high strength and excellent thermal stability were obtained. Recently Preston and Black independently reported the results of their preparation of a series of copolymers, including one containing aromatic imide linkages contributed by one of the constituents. This paper deals with the synthesis of various types of benzimidazole-aromatic imide copolymers, and the measurement of their mechanical and thermal properties. Author

N68-27172 California Univ., Berkeley.

THE MOLECULAR-BEAM ELECTRIC-RESONANCE SPECTRA OF LITHIUM FLUORIDE, SODIUM FLUORIDE, AND POTASSIUM CHLORIDE

Craig Dee Hollowell (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-8579

Radio-frequency spectra have been observed in the low vibrational and rotational states of $^{6}\mathrm{Li}^{19}\mathrm{F}$, $^{7}\mathrm{Li}^{19}\mathrm{F}$, $^{23}\mathrm{Na}^{19}\mathrm{F}$, $^{39}\mathrm{K}^{35}\mathrm{Cl}$, and $^{39}\mathrm{K}^{37}\mathrm{Cl}$ by the molecular-beam electric resonance method. Microwave $J = 1 \rightarrow 0$ transitions have also been observed for $^{23}\mathrm{Na}^{19}\mathrm{F}$. Analysis of the spectra has made possible the determination of accurate dipole moments, rotational constants, and nuclear hyperfine interaction constants. A polarizable ion model of the alkali halide molecules is presented. This model includes several effects, previously neglected, and successfully agrees with experimental data. Dissert. Abstr.

N68-27235 California Univ., Berkeley.

THE FARADAY EFFECT IN ORGANIC MOLECULES AND COMPLEXES. CONFORMATIONS OF CELLULOSE TRIACETATE

James Meyers Thorne (Ph.D. Thesis) 1966 166 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-8660

A number of aromatic hydrocarbons in solution are shown to rotate the plane of polarized light when placed in a magnetic field. This phenomenon is known as the Faraday Effect and can be measured with accuracy from 2400 Å to 7000 Å through the use of a suitably designed permanent magnet assembly and a Cary 60 spectropolarimeter. Both qualitative and quantitative aspects of recent quantum mechanical theories of the Faraday effect are shown to be in harmony with the experimental results. It is demonstrated that electronic transitions not obvious in absorption spectra can be revealed by the Faraday effect. In Part II, it is shown on the basis of polarimetry and molecular model studies that cellulose triacetate can, and very probably does, exist in different conformations in two different solvents, and also in films which have received different chemical and physical treatments. Dissert. Abstr.

N68-27240 Michigan State Univ., East Lansing.

QUANTUM MECHANICAL ANALYSIS OF HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE SPECTRA

Yuh-Kang Pan (Ph.D. Thesis) 1966 110 p

Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7591

The quantum mechanical and algebraic procedures involved in the analysis of high-resolution nuclear magnetic resonance spectra were investigated. Particular attention has been given to developing a convenient computer program for calculating matrix elements of the high-resolution nuclear magnetic resonance spin-coupling Hamiltonian. The derivations of general equations for the chemical shifts and spin coupling constants of a number of systems of nuclei with spin 1/2 in terms of the values of the experimental energy levels have been developed and presented. A computer technique for assigning the observed spectral lines to transitions within the energy-level diagram in a manner consistent with equal-spacing and intensity-sum rules has been described. It has been shown that the analysis of many complex NMR spectra can be reduced to the problem of assigning observed spectral lines to the appropriate transitions with schematic energy level diagrams, followed by direct calculation of the desired spin parameters. Dissert. Abstr.

N68-27309*# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Chemistry.

THE EQUILIBRIUM MELTING OF POLYMERS

Bernhard Wunderlich and Bruce Prime [1966] 4 p refs

Presented at the Intern. Union of Pure and Applied. Chem., Tokyo, 28 Sep.–4 Oct. 1966 Submitted for publication

(Grant NsG-100)

(NASA-CR-75474) CFSTI: $3.00/MF$0.65 CSCL 11I

Based on the results of experiments for growing polymer crystals which have their molecular chain fully or at least largely extended, equilibrium melting equations are developed. A multicomponent eutectic melting equation is also derived to describe the melting of a broad molecular weight homopolymer. Dissolution and dilatometric experiments were conducted on linear polyethylene to verify the validity of these equations. The data indicate: (1) If crystals which are close to equilibrium are molten, keeping equilibrium throughout the experiments, previously derived equilibrium melting equations can be used. (2) A self-consistent set of homopolymers crystallized with a largely extended chain conformation seems to be caused by a diluent effect of the lower molecular weight. (3) The chosen pressure crystallization conditions seemed to be able to achieve separation into different molecular weight crystals up to about 15,000 molecular weight. A.L.

N68-27313# TRW Systems Group, Redondo Beach, Calif.

VOLTAMMETRIC STUDIES ON NON-AQUEOUS SYSTEMS Final Technical Report, 1 Jul. 1966–31 Aug. 1967

R. F. Fogle, E. T. Seo, and H. P. Silverman Dec. 1967 122 p refs

(Contract DA-28-043-AMC-02464(E))

(ECOM-02464-F; Rept.-2; AD-668936)

Voltammetric studies of the reduction of organic compounds in organic solvents were undertaken as part of a program to develop high-energy density organic electrolyte batteries. Cyclic voltammetry was used as a major diagnostic tool for evaluating organic oxidizing agents as possible high-energy density cathode materials, and to elucidate the mechanisms of a heterogeneous electron transfer and any homogeneous follow-up chemical reactions. Author (TAB)

N68-27364# American Meteorological Society, Boston, Mass.

THE CHROMIUM CONTENT OF RUBIES

F. I. Pashkovskaia *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 1–5 (See N68-27363 16-18)

In efforts to develop a formula for a mixture to produce dark red rubies, several analyses of the chromium content of rubies were made to determine the effect of Ca and Mg impurities on the quality of corundum. Attention was centered on the problem of how much chromium burns up during corundum crystallization when the amount of chromic oxide introduced into the charge is varied, and on the effect of various additional impurities on the color intensity of crystals and their chromium content. Analytical data are presented to show: (1) The presence of calcium in the sample increases the amount of chromium that isomorphically enters the corundum lattice. (2) Titanium and vanadium help retain the chromium in the boule, while copper, in the absence of titanium, facilitates its burning. (3) The chromium introduced into the charge burns during the process of corundum crystallization; the amount that burns up is directly proportional to the amount introduced into the charge. (4) In analyzing a dark ruby, a significant deviation in the results is obtained if the boule is analyzed as a whole and then without its surface layer. M.G.J.

N68-27365# American Meteorological Society, Boston, Mass.

CHROMIC OXIDE CONTENT IN A CHARGE AND IN A SYNTHETIC RUBY

A. A. Kiselev and L. M. Dolgova *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 6–14 (See N68-27363 16-18)

Chemical analyses were conducted on ruby boules to determine chromium concentrations and to establish at which stage of the synthesis process maximum loss of chromium occurred. The overall losses of Cr_2O_3 in calcination of the charge into powder and in crystallization of the powder into boules are listed. Histograms are included to depict the change in Cr_2O_3 content during the production of a synthetic ruby. It was found that chromium is lost primarily in crystallization of the boule from the powder. Other data show: (1) The concentration of Cr_2O_3 in a synthetic corundum single crystal can be increased up to a definite limit only (less than 2.5%). (2) The surplus Cr_2O_3 in the powder burns up during crystallization or withdraws to the surface of the boule, where it is concentrated as an opaque coating. (3) It is inadvisable to introduce ammonium bichromate into the charge in an amount greater than 1% of the initial amound of alum, since a further increase in ammonium bichromate additive does not produce an increase in chromium concentration in the single crystal. M.G.J.

N68-27366# American Meteorological Society, Boston, Mass.

RESULTS OF SPECTROSCOPIC ANALYSIS OF CORUNDUM

S. V. Grum–Grzhimailo *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 15–25 (See N68-27363 16-18)

Numerical data and histograms are presented to show the content of different elements in ruby and colorless corundum boules, as determined by spectroscopic analysis. This impurities are listed as magnesium, silicon, iron, copper, calcium, manganese, titanium, vanadium, sodium, tin, and chromium. Magnesium and silicon were detected in all samples; most samples contained iron; about half contained copper. Calcium and manganese were present in roughly 40% of the samples. Chromium was found in the colorless samples, and was also detected in white sapphires into which Ca and Mg were introduced. M.G.J.

N68-27418*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MASS SPECTROMETER PYROLYSIS OF AMMONIUM PERCHLORATE AT LOW PRESSURE

Gerald L. Pellett and Andrew R. Saunders [1966] 18 p refs
Presented at the 3rd ICRPG Combust. Conf., Kennedy Space Center, 17–21 Oct. 1966
(NASA-TM-X-59227) CFSTI: HC$3.00/MF$0.65 CSCL 07B

In an effort to further the understanding of the ammonium perchlorate (AP) decomposition and dissociation-sublimation processes, a mass spectrometer technique was employed to examine its pyrolysis behavior under high vacuum conditions where secondary reaction effects are minimized. The results of this study demonstrate that the decomposition product distributions, the rates of decomposition, and the activation energies associated with decomposition are different in a number of respects from those previously reported in studies at higher pressures. Author

N68-27422 Michigan Univ., Ann Arbor.

AN MO THEORY OF THE CUBIC FIELD SPLITTING OF THE S-STATE IONS IN II-VI COMPOUNDS OF T_d SYMMETRY

Gholam-Hossein Azarbayejani (Ph.D. Thesis) 1966 147 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8208

Molecular orbital techniques have been employed to find the cubic field splitting 3a of $(3d)^5\ ^6S$ ions in II-VI compounds to T_d symmetry. The parameter 3a is calculated by perturbation analysis, through spin-orbit interaction. The perturbation calculations have been carried out up to the fourth order which is the lowest order necessary for the splitting 3a to occur. Numerical results are obtained for states $|\chi\ S = 5/2\ h>$ of Fe^{3+} in the series of ZnS and ZnSe compounds with a reasonable set of coefficients of linear combination of atomic orbitals and an average promotion energy of 32000 cm^{-1} Dissert. Abstr.

N68-27610*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

QUANTITATIVE ANALYSIS OF LIQUID OXYGEN-LIQUID HYDROGEN COMBUSTION PRODUCTS

Gilbert Boyd and David E. Kuivinen [1967] 7 p Presented at the 24th Meeting of the Interagency Chem. Rocket Propulsion Group, Canoga Park, Calif. 23–25 May 1967
(NASA-TM-X-52304) CFSTI: HC$3.00/MF$0.65 CSCL 07D

A method was developed for the quantitative analysis of the combustion products obtained from the firing of a liquid oxygen-liquid hydrogen rocket engine. The fixed gases hydrogen, oxygen, nitrogen, and helium were determined by use of an analytical mass spectrometer. The inletting system of the mass spectrometer has been modified for high pressure sampling. Samples were obtained at the time of the rocket test run at the chamber pressure of the engine using a high pressure gas cylinder. The concentration of water was determined by a two-phase analysis. The vapor phase was analyzed by a sorption hygrometer and the liquid phase by weighing a tared desiccant column. The weighing technique was cross-checked by weighing the samnle cylinder dry as well as wet. The water was quantitatively recovered. Author

N68-27626 Princeton Univ., N. J.

INVESTIGATIONS INTO THE ORIGIN OF BARRIERS TO INTERNAL ROTATION IN AN LC(HARTREE-FOCK) AO MO SCF APPROXIMATION

William Henry Fink (Ph.D. Thesis) 1966 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-5715

The origin of the barrier to internal rotation in the molecules CH_3CH_3, CH_3NH_2, CH_3OH, and H_2O_2 has been investigated within the Hartree–Fock approximation. LC(Hartree–Fock)AO MO SCF wave functions have been obtained and the energy changes during internal rotation calculated. Agreement between the calculated and experimental values is so striking as to be considered conclusive proof that the origin of the barrier to internal rotation is to be found within the Hartree–Fock approximation. Some attempt to elucidate the origin of the barrier to internal rotation has been performed by a decomposition of the barrier energies into the canonoical components of nuclear repulsion, electron-nuclear attraction and kinetic energy, and electron–electron repulsion. On the basis of the changes that these components undergo, a physical picture of the rotational barrier has been evolved which considers the interactions of X–H bonds, lone pairs, and protons. A preliminary study which considered the frequency distribution of electron repulsion integrals as a function of magnitude has been included as well as three subsequent analyses which were performed on the wave functions obtained. Dissert. Abstr.

N68-27648 Pittsburgh Univ., Pa.

THE INFRARED AND RAMAN SPECTRA, AND STRUCTURE, OF SELECTED COMPOUNDS

Donald H. Lemmon (Ph.D. Thesis) 1966 70 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-9722

The purpose of this work was to record the vibrational spectra of some selected compounds and thereby to determine the symmetry of the molecules. The following compounds were prepared: $P(C \equiv CH)_3$, $AS(C \equiv CH)_3$, $Sb(C \equiv CH)_3$, $N \equiv C–C \equiv C–C \equiv C–C \equiv N$, Cl_3 SiSH, and Cl_3SiCN. The syntheses has been reported by previous workers, but some improvements were made. Infrared and Raman vibrational spectra were obtained satisfactorily for all these compounds except Cl_3SiCN; only a few frequencies were established for the latter. No complete spectroscopic study has been previously reported for any of these compounds. A study of the spectroscopic data showed that $P(C \equiv CH)_3$, $As(C \equiv CH)_3$, and $Sb(C \equiv CH)_3$ have C_{3v} symmetry, *i.e.*, are trigonal pyramids. The spectra of $N \equiv C–C \equiv C–C \equiv C–C \equiv N$ fit $D_{\infty h}$ symmetry. Cl_3SiSH was found to have C_s symmetry. Dissert. Abstr.

N68-27666 Oklahoma Univ., Norman.

THE SORPTION KINETICS AND MECHANICAL PROPERTIES OF DILUTE COLUMBIUM–HYDROGEN SOLUTIONS

Thomas Glenn Oakwood (Ph.D. Thesis) 1967 125 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-9952

The sorption kinetics and mechanical properties of dilute columbium–hydrogen solutions were investigated. The sorption kinetics, measured by a thermal equilibrium technique, were found to be sensitive to surface condition and insensitive to grain size. The sorption rate was adequately described by a diffusion controlled reaction in the temperature range 600°C to 750°C provided that the metal surface was abraded to remove effects of chemical etching. Below 600°C a surface step reaction apparently controls the sorption process, rather than bulk diffusion. Hydrogen was found to have little effect on the strength of columbium in the temperature range 77°K to 300°K. The ductility of hydrogenated columbium, however, was found to be sensitive to hydrogen concentration, temperature, and microstructure. Crack formation appears to be due to a hydride precipitation in localized regions of high hydrogen concentration. Hydrogen diffusion to the microcracks from the surrounding regions is evidently responsible for crack propagation. Dissert Abstr.

N68-27717 Rhode Island Univ., Kingston.

PYROLYSIS OF SIMPLE ORGANIC MOLECULES BY GAS CHROMATOGRAPHY

Thomas Wolf (Ph.D. Thesis) 1966 372 p
Available from Univ. Microfilms: HC $16.90/MF $4.75 Order No. 67-9128

Extending the range of gas chromatography to investigating new types of sample has on occasion required the use of high inlet and column temperatures. Pyrolysis of samples not otherwise amenable to gas chromatography has become common place. This investigation was undertaken to study how the products of pyrolysis changed with temperature for representative organic groupings containing carbon, hydrogen and oxygen. Seventeen monofunctional and three difunctional organic materials not containing over six carbon atoms each were thermally decomposed in a flow of inert carrier gas by a furnace constructed by the author. Few pyrolysis products were found in large amounts with the exception of methane, carbon monoxide, hydrogen and water. Dissert. Abstr.

N68-27731 Wisconsin Univ., Madison.

ADSORPTION OF ELECTROACTIVE SPECIES IN STATIONARY ELECTRODE POLAROGRAPHY

Robert Harold Wopschall (Ph.D. Thesis) 1967 248 p
Available from Univ. Microfilms: HC $11.25/MF $3.20 Order No. 67-4962

The theory of stationary electrode polarography for single scan and cyclic triangular wave experiments has been extended to describe electrochemical systems where either the reactant, the product, or both the reactant and product, are adsorbed at the electrode-solution interface (Langmuir isotherm), and also systems involving adsorption of the reactant where the charge transfer is followed by an irreversible chemical reaction. A numerical method was applied to solve the integral equations obtained from the boundary value problems, and extensive data were calculated which made it possible to characterize quantitatively the adsorption and kinetic parameters of the system. Correlation of theoretical and experimental parameters made it possible to develop diagnostic criteria so that unknown systems could be characterized by studying the variation of peak shape, peak current, and the ratio of the anodic to cathodic peak currents as a function of scan rate and bulk concentration. In general, the theory developed was found to be useful in qualitatively and quantitatively evaluating adsorption of electroactive species in stationary electrode polarography. Dissert. Abstr.

N68-27776 Wisconsin Univ., Madison.

NUCLEAR MAGNETIC RELAXATION AND SPIN DIFFUSION IN MULTICOMPONENT SYSTEMS

Bruce David Boss (Ph.D. Thesis) 1967 236 p
Available from Univ. Microfilms: HC $10.80/MF $3.05 Order No. 67-4935

We report here pulsed-gradient, spin-echo studies of self-diffusion of polymer and diluent in high molecular weight (viscosity average $M \approx 1.5 \times 10^6$, very little below $M \approx 0.5 \times 10^6$) polyisobutylene-benzene mixtures at 70°C from 38.5 to 100 volume percent v_1 of benzene. The benzene data below $v_1 = 94.5$ follow the Fujita–Doolittle free volume theory. Above $v_1 = 94.5$, the deviations are attributed to the disappearance of polymer coil overlap. The Fujita–Doolittle parameters were determined to be as follows: $f(0,t) = 0.117$, $\beta(t) = 0.104$, $D_o = 7.66 \times 10^{-7}$ cm^2/sec. The smallest polymer diffusion coefficient that it was practical to measure was $(2.7 \pm 1.) \times 10^{-9}$ cm^2/sec at $v_1 = 93.2$. A three rf-pulse sequence (180°, 90°, 180°) was developed in the course of the polymer measurements. This method of performing a spin-echo experiment can discriminate against the signal from one component of a mixture. This was shown to have broad applications to studies of diffusion in binary mixtures. Dissert. Abstr.

N68-27782 California Univ., Los Angeles.

THE ELECTROCHEMICAL BEHAVIOR OF NICKEL, IRON, AND NICKEL-IRON ALLOYS IN SULFURIC ACIDS, PARTS 1 AND 2

Reizo Ray Sayano (Ph.D. Thesis) 1967 200 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-7399

The nickel–iron alloys in the composition range of 0 to 100% nickel were investigated to determine their corrosion rates and their general electrochemical behavior in deaerated 1N H_2SO_4 solutions. The corrosion rate was investigated by four independent methods: 1) continuous cathodic and polarization (increasing and decreasing current density), 2) pulse cathodic and anodic polarization, 3) weight-loss of the sample, and 4) chemical analysis of the electrolyte. The corrosion rates determined by these various methods were in agreement with a maximum deviation of less than an order of magnitude for any given alloy composition. Furthermore, the weight-loss and chemical analysis revealed a minimum in the corrosion rate at 60% nickel content. The minimum in corrosion rates by the electrochemical methods (pulse and continuous), a minimum in capacitance, and a maximum in open-circuit (corrosion) potential was observed at 80% nickel composition. Dissert. Abstr.

N68-27790# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Fuel Materials Branch.

ON THE CHEMICAL STABILITY OF UO_2 AND PuO_2 FUELLED GRAPHITE

P. O. Perron Feb. 1968 58 p refs
(AECL-2783) Available from Atomic Energy of Can., Ltd., Chalk River: $1.50

The thermochemical stability of UO_2 and PuO_2 fuelled graphite was evaluated to determine the stable products resulting from the interactions between oxide and carbon during irradiation of the fuel. The various pressure-controlling factors are outlined and discussed. These include (1) the initial average oxygen/metal ratio of the oxide dispersed in graphite, (2) the temperature profile across the fuel, (3) the ratio of the mass of the oxide dispersed in graphite to the free volume of fuel, and (4) the availability of oxygen-containing gases in the fuel. Calculations were carried out for cylindrical fuel elements with an axial temperature of 1400°C and surface temperature of 600°C to illustrate the interactions of the pressure-controlling factors. Consideration of specific examples indicated that the equilibrium CO pressure inside PuO_2 and UO_2 fuelled composites would be below 10 atm if the only source of oxygen is that chemically bound to the oxide. A range of temperatures and pressures is given for heat-treating the fuel so as to ensure its chemical stability under irradiation at temperatures up to 1650°C. The possibility of sorption of oxygen and moisture by the fuels between their heat-treatment and their sheathing is also considered. B.S.D.

N68-27807 Columbia Univ., New York.

RAPID CHRONOPOTENTIOMETRY: EFFECTS OF DOUBLE LAYER CHARGING AND ADSORPTION

Daniel Christopher Noonan (Ph.D. Thesis) 1967 156 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-9360

A variety of methods have been proposed for obtaining transition times from chronopotentiometric data. A comparison of these methods on the diffusion limited system cadmium in nitrate when double layer effects are appreciable is presented. It is demonstrated that none of the techniques gives adequate double layer correction but one is markedly superior to the others in terms of convenience and precision. Moreover a simple, split-current analytical correction appears to eliminate most of the effects of the double layer in data obtained by its application. In extreme cases the effect of the double layer so distorts chronopotentiometric potential time curves that no transition time can be obtained. It is shown that by application of a derivative readout technique and abandonment of the usual transition time formalism quantitative kinetic studies can be performed at very short times (less than a millisecond). Dissert. Abstr.

N68-27810 Rensselaer Polytechnic Inst., Troy, N. Y.

ELECTROCHEMICAL MEASUREMENT OF LOW CORROSION RATE

Denny Alan Jones (Ph.D. Thesis) 1966 36 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-4176

Materials possessing corrosion rates of 0.1 mpy or less are required in many applications. In this investigation, the application of linear polarization to the measurement of low corrosion rates is examined. Also, two new electrochemical techniques are theoretically derived and experimentally verified. These methods can accurately measure corrosion rates less than 0.0005 mpy and require 20 minutes or less to perform. Dissert. Abstr.

N68-27826 Rutgers Univ., New Brunswick, N. J.

SOLID SOLUTION OF ALUMINIM OXIDE IN RUTILE TITANIUM DIOXIDE

Richard Algimantas Slepetys (Ph.D. Thesis) 1967 92 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-9265

The solubility of Al_2O_3 in rutile TiO_2 was determined in the temperature region of 1200–1426°C from the change of the *c* unit cell parameter and by extrapolation of intensities of the solute phase diffraction lines to zero. The effect of dissolved Al_2O_3 on the density of rutile, and the effect of Nb_2O_5 additions on the solubility equilibrium were also determined. Dissert. Abstr.

N68-27842 Wisconsin Univ., Madison.

SOME ASPECTS OF MECHANISTIC PHOTOCHEMISTRY

Richard Spencer Givens (Ph.D. Thesis) 1967 175 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-488

The photo-rearrangement of a series of dibenzoylethylenes and the mechanism of this transformation are described. Thus, *cis*-dibenzoylstilbene and *cis*-dibenzoylethylene when irradiated in alcohol solvents give the esters of 2,3,4-triphenyl-4-phenoxy-3-butenoic acid and 4-phenyl-4-phenoxy-3-butenoic acid, respectively. The photorearrangement of benzobicyclo-(2.2.2)octatriene to benzccyclooctatetraene and benzotricyclo octadiene is described. The mechanistic pathway for this and the bicyclo(2.2.2)octatriene (barrelene) are discussed and evidence is given favoring one route. This was done by selectively deuterating the barrelene and benzobarrelene vinyl positions and observing by nmr the appearance of the unlabelled positions after photorearrangement.

Dissert. Abstr.

N68-27880# Technische Hochschule Munchen (West Germany). Institut fuer Radiochemie.

CHEMICAL ANALYSIS OF PLANET SURFACES BY LANDING SONDES—THEIR MEANING FOR THE INVESTIGATION OF EXTRATERRESTRIAL LIFE [CHEMISCHE ANALYSE VON PLANETENOBERFLAECHEN DURCH LANDENSONDEN. IHRE BEDEUTUNG FUER DIE ERFORSCHUNG EXTRATERRESTRISCHEN LEBENS]

Dieter Schmidt *In* DVL Contrib. to Space Biol. and Biophys. Apr. 1968 p 80–98 refs (See N68-27875 16-04)

A review is presented covering some of the more important analytical methods that have been proposed or developed for determining chemical data by means of unmanned space probes. Information about the chemical composition of the surface and atmospheres of planets gives some evidence for the probability of finding extraterrestrial life. Instrumental methods have been compiled and reviewed: (1) for remote chemical analysis by examining the emitted or absorbed electromagnetic radiation,; and (2) for direct analysis by sampling or placing the device in close contact to the crust or atmosphere of the planet. Special emphasis is placed on procedures for determining organic compounds (gas chromatography) and investigating soils (differential thermal analysis). A survey of instruments and principles for the detection of extraterrestrial life is given. Author

N68-27882 Princeton Univ., N. J.

THE STEREOCHEMISTRY OF GROUPS IN MOLECULES: APPLICATIONS TO N.M.R. SPECTROSCOPY, ASYMMETRIC SYNTHESIS AND THE DETERMINATION OF OPTICAL PURITY

Morton Raban (Ph.D. Thesis) 1967 170 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-9609

Stereochemical classification divides atoms or groups of atoms into three categories: (1) Equivalent groups; (2) enantiotopic groups; and (3) diastereotopic groups. The application of the symmetry classification of groups and faces to a variety of stereochemical problems, including problems in n.m.r. spectroscopy, asymmetric synthesis and the determination of optical purity, is discussed. The chemical shift nonequivalence of diastereotopic nuclei is analyzed in terms of contributions due to "conformer populations" and "intrinsic diastereomerism," and quantitative estimates of these two quantities are presented for 1,2-dibromo-1-chloro-1,2,2-trifluoroethane and 1,2-dibromo-1-chloro-2,2-difluoroethane. The oxidation of unsymmetrical sulfides with (+)-percamphoric acid results in optically active sulfoxides. A new method for the determination of optical purity using n.m.r. spectroscopy is described and applied. The optical purity of sulfoxides was estimated by integration of the n.m.r. spectrum of a mixture of diastereomeric sulfinate esters which was converted into a mixture of enantiomeric sulfoxides. It was concluded that the sulfinyl lone pair of electrons behaves *as if* it is more bulky than the sulfinyl oxygen and that the anisotropy of the sulfinyl grouping can be interpreted in terms of a shielding cone qualitatively similar to that of the carbonyl group. The optical purities of 2-propanol-1,1,1-d_3 and neopentyl alcohol-1-*d* were determined by conversion to the O-methylmandelates.

Dissert. Abstr.

N68-27894 Western Reserve Univ., Cleveland, Ohio.

THE ELECTROCHEMICAL AND DISSOLUTION PROPERTIES OF NICKEL OXIDE

Alan Theodore Riga (Ph.D. Thesis) 1967 176 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-8848

The rates of dissolution of lithiated NiO single crystals have been measured at controlled potentials in 1 $\underline{M}$ HCl and 0.5 $\underline{M}$ H_2SO_4 solutions by analyzing the solutions for nickel spectrophotometrically. The dependence of the logarithm of the dissolution rates on potential for lithiated single crystal nickel oxide prepared by the method of Cech and Alessandrini and infused with lithium at 1600°C with a technique similar to that used by Rouse and Weininger has been demonstrated. The dependence of the dissolution rate on the concentration of lithium or Ni (III) cannot be fully established from the present data. Though the range of concentrations was limited, the data certainly suggests that the rate of dissolution increases with increasing concentrations of Ni(III). The variation of the logarithm of the dissolution rate of lithiated NiO in 1 $\underline{M}$ HCl with the reciprocal of the absolute temperature indicates a linear dependence over the narrow temperature range of 70° to 95°C. *In situ* photomicroscopy indicates that the mode of attack by HCl on the (100) oriented NiO surface is dependent on potential. The dependence of the dissolution rate on potential can be explained on the basis the dissolution involves the transmission of cations and anions of the lattice over potential energy barriers, the heights of which are dependent on the potential drop across the oxide-solution interface. If the cation barrier is higher than that for anions, then an increase in dissolution rate with increasing anodic potential would be expected. Dissert. Abstr.

N68-27972*# Avco Corp., Lowell, Mass. Space Systems Div.

INFRARED TEMPERATURE SOUNDING EXPERIMENTAL STUDY Final Report, 22 Aug. 1967–19 Apr. 1968

Robert A. McClatchey Apr. 1968 64 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952037)
(NASA-CR-95265) CFSTI: HC$3.00/MF$0.65 CSCL 07D

Research performed during the past eight months on theoretical aspects of an infrared temperature sounding experiment is presented. The primary goal of this research has been to develop and improve methods of analysis which will be of direct use in the reduction of infrared spectral radiance measured with instrumentation being developed at the Jet Propulsion Laboratory. The theoretical analyses performed in some cases places restrictions on the instrumentation. Emphasis has been placed on the calculations of water vapor transmittance in the 6.3μ region and on the inclusion of absorption due to CO, N_2, N_2O and H_2O on the CO_2 absorption in the 4.3μ region. A considerable amount of effort was placed on detailing the Radiance computer program and on the problem of the uniqueness of solution of the radiative transfer equation applied to a simple 2-layer model. Author

N68-27973*# Brigham Young Univ., Provo, Utah. Dept. of Chemistry.

STUDIES OF REACTION GEOMETRY IN OXIDATION AND REDUCTION OF THE ALKALINE SILVER ELECTRODE Final Report

Eliot A. Butler and Angus U. Blackham 15 May 1968 50 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951911)
(NASA-CR-95267) CFSTI: HC$3.00/MF$0.65 CSCL 07D

A method for measuring potential variation around a working electrode has been used to measure the current variation around the working electrode. The effect of electrolyte conductivity, average current density, and electrode size, has been determined. The experimental results are compared with a theoretical analysis of current variation. A check on surface area measurements has been made by forming sintered silver electrodes from spherical silver particles. Surface areas are calculated from the dimensions of the silver particles and compared with areas measured by constant current technique. A coulometric potentiostatic method for surface area estimation has been tried and found to show promise in some preliminary experiments. An area of a sintered silver electrode compared favorably with that measured by constant current technique. Silver foil electrodes which were oxidized while being subjected to ultrasonic vibrations demonstrated an increase in charging capacity of 10–35% over electrodes not subjected to the vibrations. The amount of increase varied with different current densities but the variation appears random. No evidence has been found supporting an increase in charging capacity caused by surface fracturing. Author

N68-27982*# Chicago Univ., Ill. Dept. of Geophysical Sciences.

RE-EVALUATION OF THE CATION DISTRIBUTION IN ORTHOPYROXENES BY THE MOESSBAUER EFFECT

David Virgo and Stefan S. Hafner [1968] 14 p refs
(Grants NsG-366; NSF GA-1134)
(NASA-CR-95357) CFSTI: HC$3.00/MF$0.65 CSCL 07D

The improved resolution of Mössbauer spectra of orthopyroxenes by measurement of the absorbers at temperatures close to liquid nitrogen is shown. Some previously published data on the ferrous ion distribution between M_1 and M_2 have been reevaluated. Author

N68-27984# California Univ., Berkeley. Lawrence Radiation Lab.

TRACER CHEMISTRY STUDIES OF NOBELIUM

Jaromir Maly, Torbjorn Sikkeland, Robert Silva, and Albert Ghiorso Dec. 1967 18 p refs
(Contract W-7405-ENG-48)
(UCRL-17996) CFSTI: HC$3.00/MF$0.65

Nobelium-255, with alpha half-life of 3-1/2 minutes, were used to study the tracer chemistry of element 102. In ion exchange and coprecipitation studies, nobelium did not exhibit the behavior expected for a member of the actinide series in the +3 valence state. Work on elution positions and solubilities of hydroxides, sulfates and fluorides suggests that the +2 oxidation state, predicted to exist in addition to the +3 state for nobelium, was the stable species in aqueous solution. Results of oxidation experiments are presented and preliminary results suggest a potential for the No^{+2}–No^{+3} couple of approximately −1 volt. Author (NSA)

N68-27986 Johns Hopkins Univ., Baltimore, Md.

FIVE STUDIES IN QUANTUM CHEMISTRY

Edward Francis Hayes (Ph.D. Thesis) 1967 212 p
Available from Univ. Microfilms: HC $9.70/MF $3.00 Order No. 67-9575

This report is a study of bond angles and bonding in group IIa metal dihalides. Experimentally it is observed that some of these species are linear while others are bent. A simple explanation for the observed trends in geometry is proposed. This explanation is based on a modification of Walsh's correlation diagrams for AB_2-type molecules, to take account of the influence of normally unfilled d orbitals on the metal atom. The time-dependent Hellmann–Feynman theorems are derived. It is suggested that the application of the time-dependent integral Hellmann–Feynman theorem and the time-dependent differential Hellmann–Feynman theorem to rate processes may be valuable. Dissert. Abstr.

N68-28006# Chicago Univ., Ill. Enrico Fermi Inst.

ELECTRON MICROSCOPE STUDIES Technical Progress Report, 1 Jun. 1967–31 May 1968

Albert V. Crewe Feb. 1968 16 p refs
(Contract AT(11-1)-1721)
(COO-1721-2) CFSTI: HC$3.00/MF$0.65

Electron microscopy research and development at the University of Chicago is outlined. Topics discussed include laboratory facilities, 30 kV microscope, 100 kV gun, field emission gun microscope, automatic camera, and theoretical studies. A listing of personnel and a bibliography of published works are also presented. NSA

N68-28021# Oak Ridge National Lab., Tenn.

PREPARATION OF SOLS AND MICROSPHERES OF ThO_2, UO_2, ThO_2–UO_2, AND ThO_2–UO_3 BY SOL–GEL TECHNIQUES

A. B. Meservey 6 Feb. 1968 44 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2128) CFSTI: HC$3.00/MF$0.65

A method was developed for preparing ThO_2–25 mole % UO_3 sols of low nitrate content by coprecipitation of thorium–uranium (VI) hydroxide from thorium–uranyl nitrate solution. Large (up to at least 500 μ in diameter) gel microspheres that exhibited no cracks could be formed in 2-ethyl-1-hexanol and fired to 1200°C in air followed by hydrogen. The fired microspheres had densities that were 99.5% of theoretical, and a high resistance to crushing (about 2 kg). Another approach, boiling UO_3 with ThO_2 sols made from $Th(OH)_4$ was also used to prepare ThO_2–25 mole % UO_3 sols. The coprecipitation method was successful for preparing stable ThO_2–UO_2 sols with widely varied thorium:uranium atom ratios. For production purposes, ThO_2–UO_2 sols are prepared by blending ThO_2 sols with UO_2 sols. The preparation of pure UO_2 sol by peptization of precipitated $U(OH)_4$ with HNO_3 was proved to be feasible; the preparation of UO_2 sol and "clay" by acetate routes showed promise. Microspheres without cracks were formed from pure precipitated–thoria sols, and a new type of thoria "clay" that is suitable for extrusion and firing to ceramic bodies was made from steam-denitrated thoria. Author (NSA)

N68-28044# Polish Academy of Sciences, Warsaw. Institute of Nuclear Research.

STUDY ON THE ANION EXCHANGE AFFINITY AND CHROMATOGRAPHIC SEPARATION OF THE RARE EARTH COMPLEXES WITH TRANS-1, 2-DIAMINOCYCLOHEXANE-N,N′-TETRAACETIC ACID

Ludmila Wodkiewixz and Rajmund Dybczynski 1967 21 p refs
(INR-P-860/VIII/C)

Anion exchange behavior of the rare earth elements in the system: Dowex 1×4 $[H_2Z^{2-}]$–aqueous solution of disodium salt of trans-1,2-diaminocyclohexane-N,N′-tetraacetic acid $/Na_2H_2Z/$ has been studied. All the lanthanides, Sc and Y form complexes of the LnZ^- type at pH 4.8. Ion exchange affinity in the lanthanide series increases in a regular manner from lanthanum to promethium and then decreases with further increase of atomic number. Apparent atomic numbers of Sc and Y in this system are 64 1/2 and 67 1/2, respectively. Separation factors of adjacent lanthanides are substantially smaller than corresponding values for Dowex 1×4 $[H_2Y^{2-}]$–Na_2H_2Y aq. system when Y^{4-} stands for EDTA anion. Some separations however can still be achieved. Heights equivalent to a theoretical plate are greater than in the corresponding EDTA system, indicating that ion exchange kinetics in DCTA system is less favorable. Author (NSA)

N68-28047# Technische Hochschule, Karlsruhe (West Germany).

INVESTIGATION OF THE MASS DISTRIBUTION OF HYDROGEN CLUSTER-IONS IN A MASS SPECTROMETER WITH ENERGY SEPARATION

K. Buchheit Feb. 1968 22 p refs Transl. into ENGLISH from German
(NP-TR-1641; CTO-482) CFSTI: HC$3.00/MF$0.65

The experimental equipment and techniques for measuring the mass distribution are described. The results are presented and discussed. NSA

N68-28069*# National Aeronautics and Space Administration, Washington, D. C.

THERMAL DISSOCIATION OF BASIC AMMONIUM ALUMINUM SULPHATE. 2: MEASUREMENTS OF THE DECOMPOSITION RATE AND ATTEMPT TO EXPLAIN THE REACTION MECHANISM [DYSOCJACJA TERMICZNA ZASADOWEGO SIARCZANU GLINOWOAMONOWEGO. 2: POMIARY SZYBKOSCI ROZKLADU I PROBA WYJASNIENIA MECHANIZMU REAKCJI]

Stanislaw Bretsznajder and Janusz Pysiak Feb. 1967 15 p refs Transl. into ENGLISH from Chem. Stosowana (Warsaw), ser. A, v. 9, no. 2, 1965 p 137–153
(NASA-TT-F-11479) CFSTI: $3.00 CSCL 07D

The thermal dissociation rate of basic ammonium aluminum sulphate and partially decomposed preparations was studied. It was found that at temperatures of 300–400°C, the dehydration of the compound occurs in the kinetic range. At temperatures of 400–470°C, the dissociation occurs in the diffusion range, and a further temperature rise causes the reaction to pass to the kinetic range. Decomposition of the preparation from which H_2O and NH_3 have been removed takes place at temperatures of 780–860°C in the diffusion range. Above 860°C, the kinetics determine the overall decomposition rate. The values of the apparent activation energies of certain steps of the dissociation are: at 470–540°C, 32.7; at 780–860°C, 45.7, and at 860–900°C, 63.0 kcal per mole. Author

N68-28081# Research Triangle Inst., Durham, N. C. Camille Dreyfus Lab.

RADIATION INDUCED EMULSION POLYMERIZATION Final Report, 1 Feb. 1964–31 Mar. 1967

V. Stannett, J. A. Gervasi, J. J. Kearney, and K. Araki 1 Dec. 1967 73 p refs
(Contract AT(40-1)-2513)
(TID-24281) CFSTI: HC$3.00/MF$0.65

Studies were made of the γ-induced emulsion polymerization of styrene and comparisons made with chemically initiated emulsion polymerization. The polymerization proceeded smoothly to high conversions at 0 and 60°C, the reaction showing a high G(-monomer) value. Complete conversions were obtained with total doses of less than 0.05 MRAD. In accordance with the behavior expected of systems having a constant rate of initiation, the molecular weight was found to decrease with decreasing temperature. The molecular weight and particle size distributions were narrower than those obtained in chemically initiated emulsion polymerizations at the same temperature. Only rhodium chloride influenced the structure of the polymer. The concentration which resulted in a significant structural change was considerably smaller than was necessary to initiate the polymerization of the dienes in the absence of radiation. The radioinduced emulsion polymerization of vinyl acetate proceeded smoothly. Rates of polymerization were found to be independent of temperature, and the molecular weight of the polymer to be independent of dose rate. Author (NSA)

N68-28082# Iowa State Univ. of Science and Technology, Ames.

TANTALUM RECOVERY FROM $TaCl_5$–CaO AND $TaCl_5$–CaF_2 REACTION PRODUCTS USING CARBONYL CHLORIDE

W. N. Svoboda and F. D. Stevenson Feb. 1968 22 p refs
(Contract W-7405-ENG-82)
(IS-1799) CFSTI: HC$3.00/MF$0.65

The recovery of tantalum from the reaction products of $TaCl_5$ with calcium oxide and calcium fluoride has been studied using carbonyl chloride as a chlorination agent. Tantalum recoveries of up to 90% were achieved in each case. It was found, however, that recovery from CaO which had been predried at 900°C was limited to 66% whereas the higher recoveries were from "undried" CaO. The parameters of reaction time and $COCl_2$ concentration were investigated. Author (NSA)

N68-28093# IIT Research Inst., Chicago, Ill. Technology Center.

NATURE OF THE INTERACTION OF SECONDARY ELECTRONS WITH CHEMICAL SYSTEMS Final Report, 1 Sep. 1961–31 Mar. 1967

Paul Feng Apr. 1968 145 p
(Contract AF 49(638)-1104)
(IITRI-U6027-4; AFOSR-68-0941; AD-669145)

The primary effort was directed toward development of the procedures and actual experiments for studies involving the interaction of low energy electrons with simple organic compounds, principally n-hexane. Both photoelectric and thermionic sources were used, the electrons were accelerated by means of electrostatic fields built in the irradiation vessel, and analysis of the products obtained was carried out using mass spectrometry and gas chromatography. Other experiments which have been performed included irradiation by low energy protons obtained by slowing down higher energy protons from a van de Graaff generator, as well as preliminary experiments using the recoil nuclei formed by neutron capture processes. Results show that although low energy electrons in the sub-KeV range and protons in the near MeV range have comparable velocities and comparable LET values, the nature of the chemical processes induced by the interaction of these two kinds of radiation may nevertheless differ from each other. Several possible alternative explanations for this phenomenon have been examined and the most plausible one appears to be a concept based on ionic reaction mechanisms for some of the products and the relative total ionization cross sections of these radiations at such energy ranges. Author (TAB)

N68-28104# Atomic Energy Commission Research Establishment, Riso (Denmark).

MANGANESE-ACTIVATED LITHIUM BORATE AS A THERMOLUMINESCENT DOSIMETRY MATERIAL

P. Christensen Oct. 1967 29 p refs
(RISO-161)

The general thermoluminescence properties of $Li_2B_4O_7$:Mn, prepared by fusion of $Li_2B_4O_7$ and $MnCl_2 \cdot 4H_2O$, were investigated. With 100 mg samples (14.2 mg/cm^2) of $Li_2B_4O_7$:Mn, containing 0.1% manganese by weight, and an initial heating rate of 19°C/sec, two glow peaks were obtained at approximately 60 and 220–240°C. The glow-peak positions and the thermoluminescence light yields of the two peaks were found to be highly dependent on the manganese content. Because of rapid decay of the low-temperature peak at room temperature, only the second peak was of interest for dosimetry. Orange-yellow light, changing to yellow-green, was visually observed to be emitted from this peak. The response to Co-60 gamma radiation was linear up to about 300 rads, where supralinearity started. Saturation was reached at approximately 3×10^6 rads. The glow-peak area for a phosphor with a manganese content of about 0.5% was about 1/3 that of LiF (TLD-700) at small doses. The sensitivity of the phosphor was independent of heat treatments in the temperature range 80–400°C and of previous gamma-ray exposures up to 3×10^7 R. A small thermoluminescence signal, introduced by exposure to light, could be quenched by adding methanol containing a few per cent hydrochloric acid. It is concluded that $Li_2B_4O_7$:Mn, a rather inexpensive, promising luminophor with attractive dosimetry properties such as energy-independent response, indifference to large pre-irradiation doses as well as previous annealing, and only slight fading, might be a favorable alternative to LiF as a dosimetry material. Author (NSA)

N68-28107# Central Electricity Generating Board, Berkeley (England). Nuclear Labs.

HIGH TEMPERATURE OXIDATION OF AN Fe/15 Cr/4 Al/1Y ALLOY IN CARBON DIOXIDE

J. M. Francis and J. A. Jutson Feb. 1968 10 p refs
(RD/B/N-1006)

The structure and composition of thin oxide films formed during high temperature oxidation of an Fe–15Cr–4Al–1Y alloy in CO_2 are reported. Over the exposure period 0.1 to 1000 hr, the rate controlling step is attributed to self-diffusion of Al^{3+} in Al_2O_3. No other phase contributes significantly to the oxidation behavior of this alloy, apart from Y_2O_3, which apparently enhances scale adhesion. Author (NSA)

N68-28108# Brookhaven National Lab., Upton, N. Y.

USE OF GAMMA RADIATION TO INITIATE POLYMERIZATION REACTIONS

L. E. Kukacka, P. Colombo, and M. Steinberg Mar. 1968 20 p refs Supported in part by AEC
(BNL-12334) CFSTI: HC$3.00/MF$0.65

A study on the radioinduced polymerization of ethylene is reported. Kinetic data and polymer properties were obtained from a series of capsule and "fall-through" type experiments. Preliminary cost estimates, based on these data, indicate potential commercial interest. A small-scale flow experiment is being operated to verify these data and to obtain larger quantities of polymer for further product characterization. Author (NSA)

N68-28127# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

SURVEY OF METHODS USED AT U. S. LABORATORIES TO MEASURE IMPURITIES IN SODIUM

T. F. Demmitt Feb. 1968 12 p refs
(Contract AT(45-1)-1830)
(BNWL-690) CFSTI: HC$3.00/MF$0.65

A survey was conducted to determine the manual analytical procedures used routinely to measure oxygen, carbon, hydrogen, nitrogen, and trace metal impurities in sodium. All of the major U. S. laboratories that either are or recently have been engaged in sodium analytical chemistry studies were surveyed. The results of the survey are presented. No attempt is made to include specific information concerning analysis methods for other impurities, e.g., fission products, particulates, etc. Author (NSA)

N68-28141# Atomic Energy Commission, Washington, D. C. Technical Information Div.

TRANSPLUTONIUM ELEMENTS A Bibliography

Feb. 1968 57 p refs
(TID-3317) CFSTI: HC$3.00/MF$0.65

A bibliography on transplutonium elements is presented in two parts. Part I comprises 345 references on the production and physical and nuclear properties of transplutonium elements in the atomic-number range $95 \leq Z \leq 101$. Part II comprises 234 references on all aspects of transmedelevium elements ($Z \geq 102$). NSA

N68-28145# Henry Ford Hospital, Detroit, Mich. Div. of Nuclear Spectroscopy and Radiation Physics.

DIFFRACTOMETRY WITH ^{55}FE AND BETA EXCITED X-RAY SOURCES Interim Report, 1 Mar. 1964–31 Aug. 1965

Luther E. Preuss, William S. Toothacker, and Claudius K. Bugenis Aug. 1967 23 p refs
(Contract AT(11-1)-1239)
(COO-1239-15) CFSTI: HC$3.00/MF$0.65

An evaluation of analytical diffraction using ^{55}Fe and beta stimulated X-radiation was undertaken. Calculation of theoretical signal levels for intermediate source strengths indicated that the intensity of the diffracted beam was in the range of low level counting methods for ^{55}Fe X-radiation and below this level with the beta stimulated X-ray sources, it being a fraction of a count per minute for the latter case. The initial diffraction experiments were carried out using X-ray counting systems and resulted in no detectable beam for the assay techniques used. A second study using methods of multichannel analysis clearly demonstrated the low level diffracted beam from a 100 mCi ^{55}Fe source. The three primary diffracted beams from LiF were shown. Intensity levels were of the order of predicted values. Earlier work had predicted demonstrable diffraction using beta excited X-ray sources fabricated with 2 to 20 mCi of beta emitter, but had not shown this experimentally. Promethium-147 beta activity levels from 50 to 250 mCi were tested with polycrystalline powder samples for diffraction by gross counting techniques. No demonstrable diffraction was obtained. Author (NSA)

N68-28160# Argonne National Lab., Ill.

SEPARATION OF TRACES OF METAL IONS FROM SODIUM MATRICES

J. Korkisch and K. A. Orlandini Feb. 1968 7 p ref
(Contract W-31-109-ENG-38)
(ANL-7421) CFSTI: HC$3.00/MF$0.65

A rapid and quantitative method for the isolation of traces of metal ions from sodium matrices (e.g., sea water) is described. The technique consists of two extractions and an ion exchange step. In the first extraction, metal ions that form stable TTA-complexes in sodium chloride solutions, which are buffered with sodium acetate to a pH of 4.7 to 6.1, are extracted with 0.1M TTA in benzene–tetrahydrofuran. More than 30 elements, including rare earths, uranium, thorium, titanium, zirconium, and hafnium, are completely extracted under these conditions. Following this extraction, other traces of metal ions (i.e., silver, mercury, and cadmium) are extracted from the same aqueous solution using 0.001M dithizone in benzene as the extractant. To remove residual sodium ion from the two organic extracts, this element is selectively adsorbed on the strongly acidic cation exchanger Dowex 50 from the organic phases after the addition of pyridine. Following this final purification step, the elements thus isolated can be determined radiometrically. Author (NSA)

N68-28186# Michigan Technological Univ., Houghton. Dept. of Chemistry and Chemical Engineering.

FUNDAMENTAL STUDIES OF CONCENTRATED ELECTROLYTE SOLUTIONS

Leslie Leifer 29 Feb. 1968 15 p ref
(Contract AT(11-1)-1712)
(COO-1712-1) CFSTI: HC$3.00/MF$0.65

Progress is reported on: Hammett acidity measurements in mixed acid-salt media, electrolyte behavior in concentrated solutions, thermodynamic properties of concentrated $HClO_4$, HCl-catalyzed ester hydrolysis, and HCl-catalyzed amide hydrolysis. NSA

N68-28190# Aeronautical Research Labs., Melbourne (Australia).

THERMOGRAVIMETRIC STUDY OF THE LOWER NITRIDE OF CHROMIUM

T. Mills May 1967 27 p refs
(ARL/MET-66) CFSTI: HC$3.00/MF$0.65

The reaction $2Cr + 1/2N_2 = Cr_2N$ was studied using a thermogravimetric technique. Cr_2N was found to have a homogeneity range of approximately 3 wt. % nitrogen. Values were calculated for the standard free energy of formation of the compound at a number of temperatures. Its standard enthalpy of formation was found to be $\Delta H^\circ = -26.720$ cal per mol and the standard entropy of formation was $\Delta S^\circ = -13.3$ cal per degree mol. Author

N68-28193 European Organization for Nuclear Research, Geneva (Switzerland). Intersecting Storage Rings Div.

THE EFFECT OF NUCLEAR RADIATION ON THE ELECTRICAL PROPERTIES OF EPOXY RESINS

Marcel Van de Voorde 17 Apr. 1968 46 p refs
(CERN-68-13) CFSTI: $3.00

Significant changes were measured in the electric properties of organic materials as a function of nuclear radiation and temperature or frequency in an effort to determine radiation resistant epoxy resin compositions and to recommend new epoxy resins that will minimize radiation induced damage effects on electrical insulation in nuclear environments. All resins with a high aromatic content and cured with an aromatic amine or anhydride were good radiation resistant materials. While polyepoxides (araldite D+HY951, for example) were degraded at room temperature by nuclear radiation doses of 2×10^8 rad, recently developed resins (araldite EPN 1.138 + HT972, for example) were absolutely undamaged at 1×10^9 rad. Tests performed indicated that crosslinking and degradation probably occurred in the various materials, and that degradation first occurred in those parts of the polymer structure that were most free to move. M.W.R.

N68-28196# United Kingdom Atomic Energy Authority, Harwell (England). Analytical Sciences Div.

THE DETERMINATION OF TRACES OF COPPER, ARSENIC AND ANTIMONY IN STEELS AND STEEL OXIDES BY NEUTRON-ACTIVATION ANALYSIS

M. Perkins and T. B. Rees Mar. 1968 19 p
(AERE-AM-106) CFSTI: HC$3.00/MF$0.65

A method for irradiation of the sample, with control standards of arsenic, antimony and copper, in a flux of approximately 10^{12} neutrons cm^{-2} sec^{-1} for about 12 hours is presented. After dissolution of the sample in the presence of carriers, trivalent arsenic is separated by distillation as the chloride at 110°C in the presence of a reducing agent. Antimony is then distilled as the trichloride at 160°C, the copper remaining in the residue. Simple radiochemical decontamination steps are then applied to each of these fractions and finally the radioactivity of the ^{76}As, ^{122}Sb and ^{64}Cu from the sample is compared with that from the control standards. Author

N68-28206# United Kingdom Atomic Energy Authority, Warrington (England). Reactor Group.

THE DETERMINATION OF CARBONATE IN SODIUM

J. A. J. Walker and E. D. France 1968 12 p refs
(TRG-1635(C)) CFSTI: HC$3.00/MF$0.65

A method is described for the determination of sodium carbonate in sodium in the range 7 to 150 ppM with a standard deviation of not greater than 1.5 ppM. The principle of the method involves the removal of sodium by distillation and the conductometric determination of the carbon dioxide evolved after acidification of the distillation residue. It is shown that when a maximum distillation temperature of 350°C is used the decomposition of sodium carbonate in nickel crucibles is negligible. Author (NSA)

N68-28227*# Air Products and Chemicals, Inc., Allentown, Pa.

STUDY, COST, AND SYSTEM ANALYSIS OF LIQUID HYDROGEN PRODUCTION Final Report

N. C. Hallett Jun. 1968 323 p refs
(Contract NAS2-3894)
(NASA-CR-73226) CFSTI: HC$3.00/MF$0.65 CSCL 07A

This report contains information related to contemplated large-scale liquid hydrogen systems. Descriptions of feasible processes and equipment are presented. Information concerning availability and cost of required raw materials and energy are projected. Composite system analyses based on preliminary NASA hypersonic transport (HST) liquid hydrogen requirements indicate estimated average product cost of 7.7 to 8.8 cents per pound. Author

N68-28234# United Kingdom Atomic Energy Authority, Harwell (England). Analytical Sciences Div.

THE DETERMINATION OF HYDROGEN AND DEUTERIUM IN ZIRCONIUM ALLOYS USING AN MS 10 MASS SPECTROMETER

K. R. J. Cottell, Marion Quarmby, and H. I. Shalgosky Mar. 1968 8 p refs
(AERE-R-5758) CFSTI: HC$3.00/MF$0.65

An MS 10 mass spectrometer has been connected to a hot vacuum extraction system and calibrated for measurements of hydrogen, deuterium and hydrogen deuteride. Analysis of samples of Zircaloys has shown that the coefficients of variation for single determinations of hydrogen and deterium are ±1.2% and 2.8% respectively; the limits of detection are 0.03μg and 0.0017 μg respectively. Author

N68-28245*# Techtran Corp., Glen Burnie, Md.

DETERMINATION OF RHENIUM IN RHENIUM-TUNGSTEN ALLOYS

Teiji Okubo and Masao Kojima Washington, D. C. NASA Jun. 1968 5 p refs Transl. into ENGLISH from Bunseki Kagaku (Tokyo), v. 16, 1967 p 1082-1084
(Contract NASw-1695)
(NASA-TT-F-11735) CFSTI: HC$3.00/MF$0.65 CSCL 07D

Spectrophotometric determination of rhenium according to thiourea method has been applied to rhenium-tungsten alloy. A sample of the alloy was fused with a mixture of sodium carbonate and potassium nitrate, and it was dissolved in water and then diluted. The method can be applicable to the rapid determination of rhenium in rhenium-tungsten alloy without separating any rhenium from a large quantity of tungsten. Author

N68-28256 Wisconsin Univ., Madison.

APPROXIMATE SOLUTIONS TO FICK'S LAW BOUNDARY VALUE PROBLEMS IN ELECTROANALYTICAL CHEMISTRY

Robert Irving Gelb (Ph.D. Thesis) 1967 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-485

An approximation method has been developed for the solution of the Fick's law diffusion equations of electroanalytical chemistry. The approximation technique involves the estimation of concentration profiles of diffusing and/or reacting materials. The method is similar in concept to the Nernst diffusion layer theory and the reaction layer theory except that the thickness of the diffusion layer is considered to be time dependent. The technique transforms the second-order partial differential equations of Fick's Second law into first-order ordinary differential equations which can be solved by usual means. The method was applied to a variety of electrochemical techniques and electrochemical systems—including cases where only diffusion was involved and also those in which homogeneous chemical reactions were coupled to charge transfers. Dissert. Abstr.

N68-28263# Department of Supply, Melbourne (Australia). Aeronautical Research Labs.

THERMOGRAVIMETRIC STUDY OF THE HIGHER NITRIDE OF CHROMIUM (CrN)

T. Mills Sep. 1967 13 p refs
(ARL/MET-69) CFSTI: HC$3.00/MF$0.65

The reaction $2\ Cr_2N + N_2 = 4CrN$ was studied using a thermogravimetric technique. The reaction was not sharply defined and exhibited irreversibility. The free energy, ΔG_F cal/4 mol of CrN, of the forward reaction for the formation of a small amount of CrN in Cr_2N was $\Delta G_F = -48220 + 35.82T$, and the free energy ΔG_R cal/2 mol of Cr_2N, for the formation of a small amount of Cr_2N in CrN was $\Delta G_R = 48280 - 36.54T$. There was a temperature region, at constant nitrogen pressure, of approximately 25°C, in which the stable product was a mixture of Cr_2N and CrN. It was not possible to account for the stability of these mixtures. The upper limiting composition of Cr_2N contained 11.32 wt%N. The CrN was found to be nitrogen deficient with a homogeneity range. At one atmosphere pressure of nitrogen the upper limiting composition of CrN contained 20.80 wt%N. Author

N68-28290# Atomic Energy Commission, New Brunswick, N. J.

ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1966 THROUGH JUNE 1967

C. J. Rodden Mar. 1968 78 p refs
(NBL-242) CFSTI: HC$3.00/MF$0.65

Research progress is reported on halogen determination in boron, determination of boron in stainless steel–boron systems, x-ray spectrographic determination of impurities in boron, spectrochemical determination of tantalum and tungsten in boron, determination of oxygen and nitrogen by inert-gas fusion, spectrophotometric determination of cobalt, spectrophotometric determination of aluminum in beryllium, dissolution of UO_2–ZrO_2–CaO wafer fuel, dissolution of niobium-coated UC–graphite fuel, storage of stabilized plutonium nitrate solutions in sealed ampoules, preliminary evaluation of method for spectrographic determination of impurities in U–Pu–Mo solutions, fusion of refractory PuO_2–UO_2 and subsequent plutonium recovery, determination of rare earths in thorium oxide samples, determination of impurities in materials by spark-source mass spectrography, solid-state controlled-potential coulometers, and a darkroom timer. NSA

N68-28301# Battelle-Northwest, Richland, Wash. Dept. of Environmental and Radiological Sciences.

NEUTRON AND PHOTON SPECTRA, DOSE RATES, AND ITS CHANGES WITH TIME SINCE CHEMICAL SEPARATION FOR HIGH-EXPOSURE PLUTONIUM

L. G. Faust Jan. 1968 16 p refs Presented at the Intern. Symp. on Nucl. Electron. and Radioprotect., Toulouse, 4–8 Mar. 1968
(Contract AT(45-1)-1830)
(BNWL-SA-1644; CONF-680302-4)

Theoretical expressions are presented, which describe the radiation levels and resultant dose rates expected from plutonium. The expression for photon dose rates is based on the isotopic composition of the plutonium, the time since chemical separation and the energies and yields of the photons accompanying radioactive decay; the expressions for neutron dose rates are based on isotopic composition, mass, and chemical/physical form. Photon energy spectra change significantly at relatively short times after chemical separation primarily due to the buildup of ^{237}U and ^{241}Am, the daughters of ^{241}Pu. The bulk of the photons are of low energies and, therefore, minimal shielding, such as can be added to glove boxes or hoods, will reduce the personnel exposure significantly. Data show that surface dose rates from plutonium containing three or more weight percent ^{241}Pu will increase a factor of two within one year of chemical separation. Neutron energy spectra are presented for PuF_4 and PuO_2. It is seen that the average energies are different and that the fission tail is present in the PuO_2 sample that contains significant quantities of the isotopes that fission spontaneously. Author (NSA)

N68-28306# Aeronautical Research Labs., Melbourne (Australia).

STUDY OF THE CR–CR$_2$ N–CRN EQUILIBRIA

T. Mills Aug. 1967 13 p refs
(ARL/MET-68) CFSTI: HC$3.00/MF$0.65

Both Cr_2N and CrN exhibit a homogeneity range. The upper limit of Cr_2N is 11.35 wt.%N, which is less than the stoichiometric value of 11.87 wt.%N; the lower limit varies from 10.45 wt.%N at 950°C to 8.7 wt.%N at 1200°C. The lattice parameters of Cr_2N (close-packed hexagonal) vary linearly with wt.%N, with a constant value of $c/a = 0.932$. The existence of a composition variation in the CrN phase is clearly shown by lattice parameter measurements. Thus, after annealing under a nitrogen pressure of 760 Torr at temperatures from 850° to 1070°C, the lattice parameter of cubic CrN measured at room temperature varies over the range $a = 4.1492$ Å to $a = 4.1448$ Å. The transition from Cr_2N to CrN is not sharp and a temperature range exists over which the stable material is Cr_2N containing a CrN precipitate. The composition of this precipitate varies with annealing temperature. Author

N68-28317 Wisconsin Univ., Madison.

ELECTROANALYTICAL STUDIES OF MERCURIC SULFIDE DEPOSITS ON A MERCURY ELECTRODE

John Phillip Haberman (Ph.D. Thesis) 1967 217 p
Available from Univ. Microfilms: HC $9.90/MF $3.00 Order No. 67-3389

The cathodic stripping method was extended to the analysis of traces of sulfide ion in aqueous solutions of 0.1 M NaOH, using a hanging mercury drop electrode. Concentrations of sulfide as dilute as 1.00×10^{-8} F were determined with excellent precision. A special cell pretreatment was derived to allow the preparation of extremely dilute sulfide solutions that were sufficiently stable for analyses. The analytical method involved the accumulation of sulfide at a mercury electrode surface by the formation of an adherent, anodic deposit. The characteristics of the electrochemical formation and dissolution of this deposit were investigated with constant current, constant potential and linearly varying potential techniques. The results indicated that the deposit was mercuric sulfide, and that amounts representing much less than a monolayer could be routinely deposited and stripped. Dissert. Abstr.

N68-28325 Columbia Univ., New York.

THE CHARACTERIZATION AND ELECTRONIC STRUCTURES OF SOME TRANSITION METAL COMPLEXES CONTAINING BENZENE-1,2-DITHIOLATE AND RELATED LIGANDS

Mary Jane Baker Hawkes (Ph.D. Thesis) 1967 183 p

Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-10588

The synthesis and properties of a series of square planar complexes are described. Their polarographic half-wave potentials, as well as magnetic and spectral behavior, are shown to be strongly dependent on the electronic nature of the substituent. A single crystal three dimensional X-ray diffraction study has revealed that the $|(n{-}C_4H_9)_4||Co(S_2C_5Cl_4)_2|$ complex contains dimeric $Co_2(S_2C_6Cl_4)_4{}^{2-}$ anions in the solid state. Dimerization occurs through the formation of two Co–S linkages of length 2.40 Å. Molecular orbital calculations were performed on two model systems, $Ni(S_2C_6H_4)_2{}^-$ and $Ni(S_2C_6Cl_4)_2{}^-$, using different approximations for the ligand valence orbitals. The m.o. description accounts for the strong dependence of the properties of these complexes on the electronic nature of the substituent by the predominant ligand character of the highest filled molecular orbitals. Dissert. Abstr.

N68-28329 California Inst. of Tech., Pasadena.

A THERMODYNAMIC STUDY OF MULTIPLE REACTION SYSTEMS AT AND NEAR EQUILIBRIUM

Chien-shih Lu (Ph.D. Thesis) 1967 110 p

Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-6160

The near-equilibrium dynamic behavior of a homogeneous batch chemical reactor in which only one reaction occurs has been studied. The system has been analyzed thermodynamically and kinetically near equilibrium. The equations obtained have been linearized and then solved by means of Laplace transform techniques. The derivation for isobaric case has been presented in detail. The solutions for other cases, which include isothermal, isochoric, and adiabatic, have also been given. A general expression for the displacement of extent of reactions and mole fractions for multiple reaction systems near equilibrium has been derived. The displacement of extent of reactions for a two-reaction system which obeys ideal solution laws under isobaric condition has also been given. The condition for a multiple reaction system to obey LeChatelier's theorem is derived. It is shown that for the system to obey the theorem the matrix composed of Onsager phenomenological coefficients must be positive definite. Expressions for the initial distribution of reactants required to maximize a desired product or to suppress an undesired product of a system of chemical reactions proceeding toward equilibrium have been derived. Dissert. Abstr.

N68-28331 Rutgers Univ., New Brunswick, N. J.

THE CRYSTAL STRUCTURES OF THE HEXAAMMINECOPPER(II) HALIDES

Thomas Martin Distler (Ph.D. Thesis) 1967 66 p

Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-9243

The structures of hexaamminecopper(II) chloride, bromide, and iodide were determined by X-ray powder diffractometry of samples in equilibrium with one atmosphere of ammonia. The space group of all three compounds is D_{4h}-F4/mmm with four molecules per unit cell. The structures of the chloride and bromide were determined by seven-parameter full-matrix least-squares refinement based on integrated intensities obtained by point counting over each diffraction peak. Both compounds have a distorted potassium chloroplatinate structure. Lattice parameters indicate that the iodide has the same structure. Thus, it appears that the $Cu(NH_3)_6{}^{++}$ ion is subject to a static Jahn–Teller distortion at room temperature. Extensive lattice-energy calculations were carried out to confirm the interrelation of the lattice parameters and complex ion configuration. The effect of temperature on the structure of hexaamminecopper(II) bromide was investigated. Dissert. Abstr.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N68-26975# Stanford Univ., Calif. Electronics Labs.

A WOLD–KOLMOGOROV APPROACH TO LINEAR LEAST SQUARES ESTIMATION. PART 1: THE FILTERING PROBLEM. PART 2: THE SMOOTHING PROBLEM

Thomas Kailath Jan. 1968 67 p refs

(Contracts AF 49(638)-1517; Nonr-225(83))

(SU-SEL-68-007; TR-7050-13; AD-668862)

CONTENTS:

1. A WOLD–KOLMOGOROV APPROACH TO LINEAR LEAST-SQUARES ESTIMATION. PART 1: THE FILTERING PROBLEM T. Kailath 44 p refs (See N68-26976 16-07)
2. A WOLD–KOLMOGOROV APPROACH TO LINEAR LEAST-SQUARES ESTIMATION. PART 2: THE SMOOTHING PROBLEM T. Kailath 19 p refs (See N68-26977 16-07)

N68-26976# Stanford Univ., Calif. Electronics Labs.

A WOLD–KOLMOGOROV APPROACH TO LINEAR LEAST SQUARES ESTIMATION. PART 1: THE FILTERING PROBLEM

Thomas Kailath *In its* A Wold–Kolmogorov Approach to Linear Least Squares Estimation. Part 1: The Filtering Probl. Part 2: The Smoothing Probl. Jan. 1968 44 p refs (See N68-26975 16-07)

The Wold–Kolmogorov approach to linear least squares approximation problems is extended to handle nonstationary continuous time processes over finite intervals, and specifically applied to obtain a simple derivation of the Kalman–Bucy recursive linear filtering of a lumped process in white noise for both continuous time and discrete time processes. The cases of colored observation noise as well as Gaussian signal and Gaussian noise are considered; and appendixes deal with (1) the Hilbert space spanned by a random process and the projection theorem, (2) the innovation process, and (3) covariance relations for lumped processes. M.W.R.

N68-26977# Stanford Univ., Calif. Electronics Labs.

A WOLD–KOLMOGOROV APPROACH TO LINEAR LEAST SQUARES ESTIMATION. PART 2: THE SMOOTHING PROBLEM

Thomas Kailath *In its* A Wold–Kolmogorov Approach to Linear Least Squares Estimation. Part 1: The Filtering Probl. Part 2: The Smoothing Probl. Jan. 1968 19 p refs (See N68-26975 16-07)

A general formula is obtained for the smoothed (or noncausal) estimation of a second-order process in white noise. The smoothing solution is shown to be completely determined by the results for the (causal) filtering problem. When the signal is a lumped process, differential equations for the smoothed estimate can easily be derived from the general formula. In several cases, both the derivations and the forms of the solution are significantly simpler than those given in the literature. Author

N68-27000# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PERISCOPE-TYPE ANTENNAS AND WIRELESS TRANSMISSION LINES

A. M. Pokras 7 Jul. 67 175 p refs Transl. into ENGLISH of the publ. "Periskopicheskiye Antenny i Besprovodnyye Linii Peredachi" Moscow, Gos. Izd. Lit. Po Vopr. Svyazi i Radio, 1963 p 1–198
(FTD-MT-64-428; AD-668524)

The book is a monograph on wireless transmission lines of energy of electromagnetic oscillations of super-high frequencies. General theory and methods of engineering calculations of wireless transmission lines are expounded. Two types of transmission lines are analyzed: a system with two active antennas and a periscopic antenna system. Consideration is given to the specific character of calculations connected with mutual location of corresponding antennas in a near zone; calculating formulas and graphs are included. Design recommendations are provided, and a method of measurement of parameters of wireless transmission lines is presented. TAB

N68-27008# Mitre Corp., Bedford, Mass.

SAMPLING THEORY AND THE TESTING OF COMMON USER COMMUNICATIONS SYSTEMS

Edward H. Harwood May 1968 26 p ref
(Contract AF 19(628)-5165)
(MTR-575; ESD-TR-68-121; AD-669091)

The techniques of sampling theory are applied to measure the performance of the plant of a common-user communication system. Based on a range of expected values of p (probability of call failure), appropriate values are derived for n (the sample size), and the rationale behind the selection of a confidence level is explained. Where sampling results indicate an identifiable cause of ineffective calls, remedial engineering work can be undertaken. By this process system performance can be improved until no readily identifiable cause of failure can be found. The work in this report was done in order to provide input to Annex H of the Overseas AUTOVON Master Test Plan. Author (TAB)

N68-27011# Florida Univ., Gainesville. Communication Sciences Lab.

UNDERWATER SPEECH COMMUNICATION

Harry Hollien, John Brandt, and James Malone 31 Dec. 1967 10 p refs
(Contract Nonr-580(20))
(CSL/ONR-12; AD-668974)

Research in progress includes speech studies on (1) Standardization of speech materials for underwater communication research; (2) Diver to diver communication; (3) Underwater speech intelligibility as a function of distance; (4) Research on addition of a cavity to the vocal tract; (5) Research on existing mouthpieces; and (6) Research on existing microphones. Other research includes (1) Studies of speech in the helium-oxygen environment and the evaluation of helium speech unscramblers; (2) Studies in underwater auditory function, emphasizing the hearing acuity and pathology of divers. TAB

N68-27026# State Univ. of New York, Stony Brook. Coll. of Engineering.

ANALYSIS AND COMPARISON OF FEEDBACK COMMUNICATIONS SYSTEMS Final Report, Dec. 1963–Mar. 1967

Peter M. Dollard Mar. 1967 25 p refs
(Contract AF 19(628)-3865)
(AFCRL-68-0179; AD-668514)

The report summarizes the results of research into problems of feedback communications systems and related problems. Some practical considerations and the sort of conclusions they lead to in the design of such systems are discussed. These affect the choices of basic feedback strategy and procedure, the type of encoding, and specific code parameters. Intersymbol interference, of interest in certain types of feedback systems, is briefly analysed. Problems of synchronization and framing, and of interchannel correlation of fading in a system with a noisy feedback channel, were discussed in earlier scientific reports which are considered as appended hereto. Author (TAB)

N68-27057 California Univ., Berkeley.

DESIGN AND PERFORMANCE OF PARAMETER MODULATION SYSTEMS

Lawrence Peter Seidman (Ph.D. Thesis) 1966 146 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8647

This dissertation considers the transmission of a finite number of parameters over a channel which adds Gaussian noise. The mapping from parameter values to transmitted waveforms is termed a parameter modulation system. First we consider methods of calculating the performance of a parameter modulation system. Then we propose and study a new class of parameter modulation systems. The statistical theory of estimation is discussed in relation to calculating performance. Using a geometric view, we derive upper and lower bounds on the probability density of the maximum likelihood estimate. Turning to the design of parameter modulation systems, we first discuss some widely used systems. These are Frequency Position Modulation (FPM) which is a form of Frequency Modulation, and Pulse Position Modulation (PPM). We propose a system, termed Gated Frequency Position Modulation (GFPM), which consists of generating an FPM signal but transmitting it only during certain periods of time. Dissert. Abstr.

N68-27059# Environmental Science Services Administration, Boulder, Colo. Research Labs.

A FLEXIBLE INCREMENTAL PHASE SERVO WITH DIGITAL OUTPUTS FOR INDICATING PHASE AND DOPPLER FREQUENCY OF IONOSPHERICALLY RADIO SIGNALS

Richard N. Grubb Mar. 1968 48 p
(ARPA Order 932)
(SDL-7; AD-668594)

A flexible solid-state phase-tracking system designed for use on ionospherically propagated radio signals is described. The output is basically digital in form and suitable for use with automatic data processing systems. The unit provides an output equal to the rate of change of phase or doppler frequency of the incoming signal and is sufficiently flexible to be used on VLF through HF signals. The design is described and specifications of the prototype unit included. Some examples of results obtained using the equipment are given. Author (TAB)

N68-27063*# Martin Co., Orlando, Fla.

PROPAGATION OF MILLIMETER AND SUBMILLIMETER WAVES

V. E. Derr Washington NASA Aug. 1967 225 p refs
(Contract NAS12-10)
(NASA-CR-863; OR-8549) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The instrumentation development for absorption measurements is discussed. Calculations and a search for O_2 submillimeter transitions are described. Spectroscopic investigations of the Stark effect in water have been used to confirm level assignment and to determine a new value of the dipole moment of water by a more accurate dc voltage method. A chemical analog of water, D_2O, has been observed near 300 GHz. A discussion of orientation relaxation theory is presented, as well as a consideration of quadrupole interaction in CO_2. A computer program that is suitable for computation of low J value transitions in asymmetric top molecules has been developed for the Kivelson–Wilson theory of centrifugal effects. Based on all available data from 100 to 1000

GHz, the absorption spectrum of water is computed by two methods with different form factors, in order to present a comparison. Author

N68-27081# Ohio State Univ., Columbus. ElectroScience Lab.

TRANSIENT CURRENTS ON A PERFECTLY CONDUCTING CYLINDER ILLUMINATED BY UNIT STEP AND IMPULSIVE PLANE WAVES

Robert H. Schafer 3 May 1968 210 p refs
(Contract F19628-67-C-0239)
(AFCRL-67-0691; Rept.-2415-2; SR-2; AD-668536)

An analytical study of the transient current density induced upon the surface of a perfectly conducting circular cylinder has been carried out. Both TE and TM incident plane waves are considered. The time dependence of the incident wave is chosen to be either that of a unit impulse or a unit step. Since exact, closed form solutions for the induced current density cannot be derived, it is necessary to separately consider the current density for small and large time intervals after the arrival of the incident plane wavefront. Using this approach, a symptotic representations of the induced current density are derived which are valid in the two extreme time ranges. The large and small-time approximations do not overlap in the moderate time zone. With the aid of two independent numerical approaches, it is found that the transient current waveforms in the moderate time zone can be reasonably approximated by a functional interpolation between the short and large-time solutions. Hence a complete analytic approximation of the current density is obtained. The numerical results which stem from this representation are presented graphically by two methods. One method presents a series of graphs of current density versus time for specific locations on the surface of the cylinder. The alternate presentation presents snapshots of the current density distribution on the circular cylinder at specific instants of time. Author (TAB)

N68-27089 California Univ., Berkeley.

CLOSED NETWORKS OF QUEUES

Richard Jay Swersey (Ph.D. Thesis) 1966 65 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-8659

A closed network of queues consists of a finite set of N customers, a finite set of M single-channel servers, and a set of arcs (i,j) which represent the allowed instantaneous movement from station i to station j. We also assume that all customers are identical in their stochastic behavior, that movement is governed by a set of given transition probabilities such that they form an irreducible Markov chain, that service times are governed by an exponential distribution, and that the imbedded Markov chain defined on the instants of service completions is irreducible. Under these assumptions steady-state operating characteristics are derived through analyses of the time-average steady-state equations and of the underlying Markov chain. Dissert. Abstr.

N68-27095# Florida Univ., Gainesville. Communication Sciences Lab.

EXHIBIT OF DIVER COMMUNICATION RESEARCH SYSTEM (DICORS)

Harry Hollien, John Brandt, and Carl L. Thompson 1 Feb. 1968 10 p
(Contract Nonr-580(20))
(CSL/ONR-14; AD-668975)

A Diver Communication Research System (DICORS) was the primary focus of two recent exhibits presented by Communication Sciences Laboratory. In addition to a fully equipped DICORS (including a mannequin which represented a diver/subject), the exhibit included displays ranging from underwater communication equipment and response units to a slide-show and photographs of facilities, equipment and procedures. A final display demonstrated the applicability of DICORS by presenting data from three studies representative of the research now underway, i.e., research on (1) underwater hearing thresholds, (2) comparative evaluation of underwater communication systems and (3) speech intelligibility in the milieu of helium-oxygen mixtures and high ambient pressure. Author (TAB)

N68-27122# Stanford Univ., Calif. Electronics Labs.

WAVE FRONT OBSERVATIONS AT 35 GHZ ON A LINE OF SIGHT, RADIO WAVE PROPAGATION PATH

R. W. Lee and A. T. Waterman, Jr. Jul. 1967 47 p refs
(Contract AF 19(628)-5054)
(SU-SEL-68-034; AFCRL-67-0696; ISR-2278-1; AD-669100)

Preliminary analyses of experimental results are described. The experiment consists of line-of-sight propagation of a 35 GHz radio wave over a 28-Km path. The propagated wave is received on an eight-element antenna array in which amplitude and phase are measured and recorded from each element separately and (nearly) instantaneously. Fluctuations imposed on the wave by the atmosphere are the subject of study. Detailed data taken on two particular occasions are discussed. Time-lagged correlations of amplitude fluctuations show motion of disturbances past the array, as well as indicate the scale length of the fluctuations and the time required for atmospheric internal motions to de-correlate the amplitude pattern. Similar correlations of phase-differences (or apparent wavefront tilts) across the array show the phase disturbances to be moving with velocities sometimes equal to those of the amplitude disturbances and sometimes different in an intriguing way. The apparent pattern velocities determined by correlation have been compared with measured spectral widths of the fluctuations. Correlation of wavefront tilt with amplitude fluctuations proves interesting, the correlation being zero at zero time lag and the sign for positive and negative lags depending upon the direction of motion of the fluctuations past the array. The amplitude and phase information has been used to compute antenna patterns, and the resulting motions of the antenna lobe have been measured. They show displacements in azimuthal angle-of-arrival as large as 30 arc-seconds. Author (TAB)

N68-27130# Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.

THE MEASUREMENT OF INTEGRATED REFRACTIVITY FOR EVALUATING ATMOSPHERE-INDUCED RADAR RANGING ERRORS

W. G. Tank *In* White Sands Missile Range Preprints of the Conf. on Unguided Rocket Ballistics Meteorology, Addendum Jan. 1968 p 123–151 refs (See N68-27126 16-20)
(D1-82-0639)

Line-integrated refractivity ($\overline{N}$) is isolated as the basic parameter required for correcting atmosphere-induced radar ranging data errors. A basis for the determination of integrated refractivity from measurements of the absorption or emission of infrared and microwave radiation by atmospheric oxygen and water vapor, with subsequent interpretation of those measurements in terms of integrated oxygen and water–vapor partial densities, is then established. Both active and passive absorption-measuring systems applicable to the range data-correction problem are described. Finally, examples of integrated oxygen and water–vapor partial densities obtained with active infrared and passive microwave instrumentation of the types described are presented. It is estimated that incorporation of such instrumentation into ranging systems will permit a real-time $\overline{N}$-measurement accuracy of about 1 percent in total $\overline{N}$. Author

N68-27210# Raytheon Co., Norwood, Mass. Communications and Data Processing Operation.

MEASUREMENT OF THE POTENTIAL EFFECTIVENESS OF TAHA IN A DIVERSITY SYSTEM Final Report

Joseph T. De Bettencourt, James F. Roche, Carson K. H. Tsao, and John S. Underwood Apr. 1968 32 p refs
(Contract DAAB07-67-C-0398)
(CDP-TR-9; ECOM-00398-F; AD-668249)

A measurement program was conducted to assess the potential effectiveness of the Tapered Aperture Horn Antenna (TAHA), at LaPlata, Maryland in a polarization diversity reception system. Measurements were made at LaPlata on HF test signals transmitted from Hawaii and Davis (San Francisco) stations. The results indicated that the two polarized components received on the two ports of TAHA have very low correlation coefficients under all ionospheric conditions encountered during a four day test period. The distributions of signal-to-noise were computed to determine the degree of improvement afforded by using TAHA in a polarization diversity system. Author (TAB)

N68-27224# Douglas Aircraft Co., Inc., Tulsa, Okla. Modification Div.
A/RIA SYSTEM CATEGORY 2 Final Test Report
Bedford, Mass. AFSC, Electron. Systems Div. Jul. 1967 266 p refs
(Contract AF 19(628)-4888)
(DEV-3796; ESD-TR-67-520, V. 2; AD-669103)

The document is volume 2 of a two-volume test report. It contains the nine appendices listed in the table of contents in volume 1 (AD-669 102). TAB

N68-27228*# Notre Dame Univ., Ind. Dept. of Electrical Engineering.
A CONSTRUCTION TECHNIQUE FOR RANDOM ERROR CORRECTING CONVOLUTIONAL CODES
Daniel J. Costello, Jr. 1 May 1968 20 p refs
(Grant NGR-15-004-026)
(NASA-CR-95142; EE-685) CFSTI: HC $3.00/MF $0.65 CSCL 09D

A simple algorithm is presented for finding rate 1/n random-error correcting convolutional codes. Good codes considerably longer than any now known are obtained. A discussion of a new distance measure for convolutional codes, called the free distance, is included. Free distance is particularly useful when considering decoding schemes, such as sequential decoding, which are not restricted to a fixed constraint length. It is also shown how the above algorithm can be modified slightly to produce codes with known free distance. Author

N68-27287# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIO 70 YEARS
A. D. Fortushenko, ed. 30 Jun. 1967 408 p refs Transl. into ENGLISH of the Publ. "Radio 70 Let" Moscow, Izd. Svyaz, 1965 p 1–334
(FTD-MT-65-496; AD-667925)

CONTENTS:

1. THE PATH OF RADIO DEVELOPMENT IN THE USSR N. D. Psurtsev p 3–11 (See N68-27288 16-07)

2. THE ROLE OF RADIO IN SPACE CONQUEST V. I. Siforov p 12–25 (See N68-27289 16-07)

3. RADIO RELAY COMMUNICATION S. V. Borodich p 26–57 ref (See N68-27290 16-07)

4. DISTANT RADIO COMMUNICATIONS ON SKY WAVES N. I. Chistyakov p 58–84 (See N68-27291 16-07)

5. DEVELOPMENT OF THE THEORY AND TECHNOLOGY OF PHASE TELEGRAPHY N. T. Petrovich p 85–92 refs (See N68-27292 16-07)

6. TECHNICAL FACILITIES OF TELEVISION NETWORK A. D. Fortushenko and M. I. Krivosheyev p 93–129 refs (See N68-27293 16-07)

7. TECHNOLOGY OF BROADCASTING I. Ye. Goron p 130–146 (See N68-27294 16-07)

8. RADAR AND RADIO NAVIGATION I. V. Brenev p 147–167 refs (See N68-27295 16-07)

9. RADIO ASTRONOMY Yu. N. Pariyskiy and S. E. Khaykin p 168–184 (See N68-27296 16-30)

10. RADAR INVESTIGATIONS OF THE SOLAR SYSTEM PLANETS B. I. Kuznetsov and I. V. Lishin p 185–201 (See N68-27297 16-30)

11. RADIO WAVE PROPAGATION M. P. Dolukhanov p 202–227 refs (See N68-27298 16-07)

12. ANTENNA TECHNOLOGY G. Z. Ayzenberg p 223–254 (See N68-27299 16-07)

13. QUANTUM RADIO ENGINEERING A. M. Prokhorov p 255–269 (See N68-27300 16-07)

14. RADIO TRANSMITTING TECHNOLOGY Z. I. Model' p 270–295 (See N68-27301 16-07)

15. RADIO RECEPTION TECHNOLOGY V. I. Siforov p 296–310 refs (See N68-27302 16-07)

16. SEMICONDUCTOR ELECTRONICS Ya. A. Fedotov p 311–332 (See N68-27303 16-10)

17. ELECTRONIC DEVICES N. D. Devyatkov p 333–348 (See N68-27304 16-09)

18. HIGH-FREQUENCY COMMUNICATION ON CABLE LINES F. B. Anosovich p 349–374 (See N68-27305 16-07)

19. TELEMETRY AND REMOTE CONTROL IN THE NATIONAL ECONOMY V. A. Il'in p 375–396 refs (See N68-27306 16-07)

N68-27288# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE PATH OF RADIO DEVELOPMENT IN THE USSR [PUTI RAZVITIYA RADIO V SSSR]
N. D. Psurtsev *In its* Radio 70 Yr. 30 Jun. 1967 p 3–11 (See N68-27287 16-07)

A chronological narrative is presented of radio development in general from the first point-to-point radio contact in 1895 to the latest space communications. Broadcasting is accepted as a vital propaganda tool. A diagram of communications satellite Molniya-1, its orbit and zone of communication are included. A figure of over 70 million is given for the total number of private radios in USSR. Television is described as the highest form of broadcasting. It is claimed that by 1965 the Soviet Union possessed 168 high power TV stations, with an additional number of low-power TV relays in excess of 300. The latest 1965 figure for TV receivers is put at 13 million. A central TV net is mentioned over which a program is transmitted to all the major cities except those of central Asia which will be added to the network in the near future. Forecast is made that mass production of transistorized TV sets is imminent. Introduction of regular color transmissions is listed as one of the problems for the next five years. Construction of the new Moscow central control transmitting tower (height 520 m.) is considered a significant step forward. A passing reference to the future uses of lasers to include communication circuits in the optical range is also included. Author

N68-27289# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ROLE OF RADIO IN SPACE CONQUEST [ROL' RADIO V OSVOYENII KOSMOSA]
V. I. Siforov *In its* Radio 70 Yr. 30 Jun. 1967 p 12–25 (See N68-27287 16-07)

A summary of radio techniques applied to exploration of outerspace is presented. Reference is made to specific significant Soviet achievements in radio astronomy. A chronology of satellite launchings follows with brief descriptions of their weight, a number of orbits for each. Lunar exploration is summarized. Attention is devoted to the first manned satellite flight of astronaut Gagarin. Flights by subsequent astronauts are enumerated. The flight of the three man space ship Voskhod is hailed as marking a new stage of space investigation whereby scientists and engineers participated directly. The article concludes with an assessment of the role to be played by artificial earth satellites in the fields of meteorology, navigation, long-distance communication, and educational television. Possibility of communication with intelligent creatures of other worlds is not excluded. Author

N68-27290# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIO RELAY COMMUNICATION [RADIORELEYNAYA SVYAZ']
S. V. Borodich *In its* Radio 70 Yr. 30 Jun. 1967 p 26–57 ref (See N68-27287 16-07)

Article presents a general summary of world-wide development of radio relay communication and its application within the Soviet Union. Under major sub-headings emphasis is devoted to the following topics: (1) radio relay lines of direct line of sight, (2) radio relay communication systems of average and small capacity, (3) troposphere radio lines, (4) basic characteristics of troposphere radio relay lines, (5) peculiarities of the equipment of troposphere radio relay lines, and (6) certain directions of developing systems of troposphere radio relay communications. Author

N68-27291# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DISTANT RADIO COMMUNICATIONS ON SKY WAVES [DAL'NYAYA RADIOSVYAZ' NA PROSTRANSTVENNYKH VOLNAKH]
N. I. Chistyakov *In its* Radio 70 Yr. 30 Jun. 1967 p 58–84 (See N68-27287 16-07)

A discussion of developments in techniques of improving long range broadcast, and forecasts of future developments is presented. Mention is made of future use of decameter waves. Present day wave problems of overcrowding, are discussed. Various technical means of increasing the effectiveness of present facilities are suggested, including side-band transmitters, radio-telegraph circuits, radio telephone devices, methods of frequency stabilization, use of relays in long range lines, such as the Soviet synchronous generator. The article closes with details of antenna improvement, and a look into the future of automation of radio communications. Author

N68-27292# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DEVELOPMENT OF THE THEORY AND TECHNOLOGY OF PHASE TELEGRAPHY [RAZVITIYE TEORII I TEKHNIKI FAZOVOGO TELEGRAFIROVANIYA]
N. T. Petrovich *In its* Radio 70 Yr. 30 Jun. 1967 p 85–92 refs (See N68-27287 16-07)

The concepts of phase telegraphy, the current state of its development, with major attention devoted to the problem of overcoming reverse operation is presented. Author

N68-27293# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TECHNICAL FACILITIES OF TELEVISION NETWORK [TEKHNICHESKIYE SREDSTVA TELEVIZIONNOGO VESHCHANIYA]
A. D. Fortushenko and M. I. Krivosheyev *In its* Radio 70 Yr. 30 Jun. 1967 p 93–129 refs (See N68-27287 16-07)

A general discussion of the growth of Soviet television in the ten year period ending in 1964 is presented. It appears that only Moscow and Leningrad have three channels for broadcasts and most major cities are limited to two, while other areas are served by a one-channel low power network. Moscow is the television broadcasting center for the central network radiating to most of the other major cities. A description of TV cameras and mobile broadcast units is included. Other topics discussed in order are: videotape, test patterns, transmitting stations and their equipment, television receiver types and their defects. It is pointed out that a transition to semi-conductor type sets would result in a saving of 1.3 million kilowatts of electric power. The article concludes with a resume on the status of color television and its basic requirement for a compatible system and the problem of standardizing a reliable set obtainable at an acceptable price. Author

N68-27294# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TECHNOLOGY OF BROADCASTING [TEKHNIKA RADIOVESCHANIYA]
I. Ye. Goron *In its* Radio 70 Yr. 30 Jun. 1967 p 130–146 (See N68-27287 16-07)

A resume of radio broadcasting development in USSR during the ten year period up to 1965 is presented. Statistics are provided on numbers of stations, receiving sets, programs offered, and number of broadcasting hours. Article may be of interest to consumers because of the many types of equipment mentioned by type designation and trade or brand name. Wire broadcasting to subscribers is described as a significant part of the overall broadcasting service and interest is indicated in the further development of stereobroadcast programs. Author

N68-27295# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADAR AND RADIO NAVIGATION [RADIOLOKATSIYA I RADIONAVIGATSIYA]
I. V. Brenev *In its* Radio 70 Yr. 30 Jun. 1967 p 147–167 refs (See N68-27287 16-07)

Radar development and radio navigation improvements are reviewed. Credit for much of the development is attributed to the demands for accurate detection and position location of fast moving objects. A discussion of passive radar and its detection is presented. Active radar and its application is included. Radio navigation is discussed, with a preference shown for a system of ground aids to navigation. The future use of navigation satellites is explored. Author

N68-27298# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIO WAVE PROPAGATION [RASPROSTRANENNIYE RADIOVOLN]
M. P. Dolukhanov *In its* Radio 70 Yr. 30 Jun. 1967 p 202–227 refs (See N68-27287 16-07)

Consideration is given to studies of radio wave propagation which has proceeded along the following lines: (1) Mastering new ranges of radio waves of both lower and higher frequencies; (2) use of probability and statistical methods for study of the peculiarities of radio wave propagation; (3) the tendency to correct more densely the processes of propagation with the problem of undistorted information transmission on communication channels; (4) mastering new methods of transmitting information for great distances by cosmic systems of radio communications. Radio waves are discussed under the classifications of ground waves, tropospheric waves, sky waves, direct waves and underground waves. Author

N68-27299# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANTENNA TECHNOLOGY [ANTENNAYA TEKHNIKA]
G. Z. Ayzenberg *In its* Radio 70 Yr. 30 Jun. 1967 p 228–254 (See N68-27287 16-07)

The article provides a short survey of antennas and related supporting devices developed during the ten years ending in 1964.

Fields of use include radio communications, broadcasting, television, radar, radio communications, broadcasting, television, radar, radio astronomy, radio control. Mention is made of present and future use of plastics in antenna construction and the use of ferrites in the antenna waveguide technology of super-high frequencies.
Author

N68-27300# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
QUANTUM RADIO ENGINEERING [KVANTOVAYA RADIOTEKHNIKA]
A. M. Prokhorov *In its* Radio 70 Yr. 30 Jun. 1967 p 255–269 (See N68-27287 16-07)

The physical principles underlying quantum electronics are reviewed with emphasis on various types of quantum generators.
Author

N68-27301# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIO TRANSMITTING TECHNOLOGY [RADIOPEREDAYUSHCHAYA TEKHNIKA]
Z. I. Model' *In its* Radio 70 Yr. 30 Jun. 1967 p 270–295 (See N68-27287 16-07)

A review of the developments in methods of radio transmitting technology, postwar development of tubes, methods of increasing power, essentials of modern transmitters including television broadcasting is presented.
Author

N68-27302# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIO RECEPTION TECHNOLOGY [RADIOPRIYEMNAYA TEKHNIKA]
V. I. Siforov *In its* Radio 70 Yr. 30 Jun. 1967 p 296–310 refs (See N68-27287 16-07)

A review of Soviet successes in improving radio receivers designed for general and special uses is presented. Attention is devoted to stereophonic receivers, suppression of noise, development of amplifiers utilizing principles of quantum electronics, and trends in the use of semiconductors and microminiature receivers.
Author

N68-27305# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HIGH-FREQUENCY COMMUNICATION ON CABLE LINES [VYSOKOCHASTOTNAYA SVYAZ' PO KABEL'NYM LINIYAM]
B. F. Anosovich *In its* Radio 70 Yr. 30 Jun. 1967 p 349–374 (See N68-27287 16-07)

The basic trends of development of the techniques of communication using cable lines are presented. The review is general in scope and touches upon multichannel equipment, coaxial cables, amplifiers, effects of underground temperature, power sources, and insulation materials. Means of locating cable damage are mentioned together with modern techniques of cable laying. General systems of cable communication networks and their operation are described. The article concludes with a prospect of future improvements aimed at increased capacity.
Author

N68-27306# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TELEMETRY AND REMOTE CONTROL IN THE NATIONAL ECONOMY [TELEMETRIYA I TELEUPRAVELNIYE V NARODNOM KHOZYAYSTVE]
V. A. Il'in *In its* Radio 70 Yr. 30 Jun. 1967 p 375–396 refs (See N68-27287 16-07)

A consideration is given to the unique role of telemetry and remote control applicable to automation and telemechanics. Impact on the national economy is considered in terms of power engineering, petroleum, gas, chemical and mining industries, machine building and metallurgy, rail, air and water transportation, agriculture, communications and meteorology. All these subjects are covered in brief statements of aspects to which remote control and telemetry are applicable. The theory of telemechanics is also discussed.
Author

N68-27382*# Northeastern Univ., Boston, Mass.
MAXIMUM LIKELIHOOD RECEIVER FOR DIGITAL DATA TRANSMISSION
Robert A. Gonsalves [1967] 8 p refs Presented at the Forthcoming IEEE Intern. Conv., 1967
(Grant NGR-22-011-013)
(NASA-CR-78333) CFSTI: HC$3.00/MF$0.65 CSCL 09F

A novel receiver structure for binary data with limited intersymbol interference uses nonlinear elements and combines features of the optimum linear and "tail cancellation" receivers. The receiver is maximim-likelihood: it is optimum in that it minimizes per-bit probability of error, P_e. Bounds on P_e and certain extensions are presented.
Author

N68-27396# Stanford Univ., Calif. Systems Techniques Lab.
WAVE-FRONT OBSERVATIONS AT 35 GHZ ON A LINE-OF-SIGHT, RADIO-WAVE PROPAGATION PATH Final Report, 1 Dec. 1966–30 Nov. 1967
R. W. Lee and A. T. Waterman, Jr. Dec. 1967 164 p refs
(Contract AF 19(628)-5054)
(SU-SEL-68-015; AFCRL-68-0096; Rept.-2278-F; AD-669101)

Recent data taken with the 2800 lambda, 8-element receiving array, at 35 GHz, over a 28-km line-of-sight path are reported. The basic data consist of amplitude and relative phase, measured separately at each antenna element in a few milliseconds, with a scan of all eight elements repeated each tenth of a second. From these data, the standard deviation of signal amplitude divided by the mean is computed, and sample from a 32-hour run in July are plotted as a function of time of day. Similarly the standard deviation of phase-difference is so plotted. In like fashion the coherence of the wavefront is determined by the data and plotted against time of day, both for the July run and for an earlier April run. The same is done for the phase structure-function. Both the measured phase structure-function and the measured amplitude covariance are compared with theoretical models of atmospheric structure involving a spectral intensity proportional to some power (-11 3, in the case of the Kolmogrov spectrum) of the turbulence wavenumber. The magnitude of the universal turbulence constant, required for consistency with the data is also obtained, and ranges slightly higher than the values observed by others. Finally, a systematic arrangement of significant data covering 67 two-minute samples taken at hourly intervals, from the April and July runs, is included. For each of the 67 samples, four graphs are presented: (a) amplitude vs time for each element, (b) phase-difference vs time for each adjacent element-pair, (c) cross covariance of amplitude vs time lag, and (d) cross covariance of phase difference vs time lag. From these, basic information is made available in quantity.
Author (TAB)

N68-27405 Cornell Univ., Ithaca, N. Y.
SEQUENTIAL CODING WITH FEEDBACK FOR A CLASS OF TIME-VARYING CHANNELS
Frank Louis Huband (Ph.D. Thesis) 1966 126 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-3789

Sequential decoding is extended to a class of slowly time-varying channels, called here the fully symmetric random walk channel (FSRWC), using decision feedback. The fully-symmetric channel is single parameter; each input X to the channel has a unique corresponding output $Y_0(X)$ such that the probability that

the channel output will be $Y_q(X)$, when the input was X, is some number q, called the direct transmission probability. A sequential coding algorithm using feedback is described, in which the feedback is used to instruct the transmitter either to increase or decrease the rate, or to ask for a repeat of a certain number of digits.
Dissert. Abstr.

N68-27542*# Raytheon Co., Norwood, Mass. Equipment Div.
ATS SSB AFC CARRIER OFFSET STUDY Final Report, 13 Apr.–27 Jul. 1966
Jul. 1966 31 p
(Contract NAS5-10176)
(NASA-CR-95101) CFSTI: HC$3.00/MF$0.65 CSCL 09F

A plan for increasing the range of the ATS SSB AFC was studied so that in addition to tracking a satellite with a Doppler shift of ±35 kc, the system is capable of acquiring and tracking a spacecraft with a carrier offset as high as ±180 kc. An initial design study is reported and alternative solutions advanced. A recommended solution employing a wide range, low noise VCO is proposed along with results of a feasibility test on a VCO. The physical implementation within the ATS-SSB Transmitter is described, and a field change procedure is recommended. Author

N68-27547*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
IMPEDANCE OF PLASMA COATED AXIAL SLOT ANTENNA
Thomas G. Campbell [1966] 21 p refs Presented at the 16th Ann. Symp. of USAF Antenna Res. and Devel., Urbana, Ill., 12–14 Oct. 1966
(NASA-TM-X-59087) CFSTI: HC$3.00/MF$0.65 CSCL 09F

A general research program is being conducted to study plasma sheath effects on the communication systems of reentry vehicles. Methods of minimizing the blackout effect are being investigated. This program is called Project RAM, for Radio Attenuation Measurements, and combines both theoretical and experimental investigations of the plasma sheath. One of the principal areas of investigation involves the study of electromagnetic wave interaction with plasma by using electron density profiles supplied by flow field analysis. As part of this research effort a research vehicle was launched from Wallops Island, Virginia on April 10, 1964 in which the prime experiment was to verify flow field predictions from electron density measurements by using onboard microwave reflectometers at discrete locations along the nose cone. Another major objective of the flight was to measure the input impedance of a narrowband and broadband VHF antenna in order to observe changes in the impedance caused by the proximity of the plasma sheath. This experiment was conducted, primarily, to observe detuning effects caused by the plasma sheath. Author

N68-27560*# Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
PERFORMANCE OF SELF BIT SYNCHRONIZATION SYSTEMS
E. J. Luecke (Valparaiso Univ.) and P. A. Wintz [1967] 23 p refs Presented at the 1967 IEEE Intern. Conf. on Commun., Minneapolis, 12–14 Jun. 1967
(Grants NGR-15-005-021; NsG-553)
(NASA-CR-87241) CFSTI: HC$3.00/MF$0.65 CSCL 09D

The optimum (maximum likelihood) estimator for the epoch of a random sequence of anticorrelated signals of known duration in additive guassian noise was derived and its performance evaluated by Monte Carlo simulation on a digital computer. The mean magnitude of the epoch error vs. signal-to-noise ratio was obtained for three symbol waveforms. The optimum system is rather complex and, therefore, judged to be impractical. However, the equation defining the optimum system structure can be loosely interpreted as a filtering operation followed by a nonlinearity followed by an averaging operation. A simple (suboptimum) system that performs these operations was considered and its performance computed via the transform method. The suboptimum system performed nearly as well as the optimum system for rounded pulses, but significantly worse for square pulses. A prototype of the suboptimum system was constructed; it performed as predicted. Author

N68-27618*# Northeastern Univ., Boston, Mass.
VARIABLE REDUNDANCY PRODUCT CODES
L. J. Weng and G. H. Sollman [1967] 14 p refs Presented at the IEEE Intern. Conv. 1967
(Grant NGR-22-011-013; Contract AF 19(628)-3312)
(NASA-CR-78334) CFSTI: HC$3.00/MF$0.65 CSCL 09D

The tensor product codes, as either iterated codes or error locating codes, possess the property of variable redundancy (allowing up to eight different levels of error control). It is shown that the implementation of an encoder for such codes can be decomposed into the implementation of the component codes. The selection of eight encoder modes yields four iterated codes and four error locating codes that lend themselves to both adaptive coding and feedback transmission strategies. Author

N68-27646*# Pennsylvania Univ., Philadelphia. Moore School of Electrical Engineering.
STUDY OF GSFC RADIO FREQUENCY INTERFERENCE DESIGN GUIDELINE FOR AEROSPACE COMMUNICATIONS SYSTEMS Final Report
25 Apr. 1967 118 p refs
(Contract NAS5-9896)
(NASA-CR-95227; Rept.-68-21) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Tracking errors caused by interference to the Minitrack system are analyzed, and the interference is categorized as (1) co-channel interference originating from other satellites transmitting in the 136 to 138 MHz space research band which happen to be passing over the ground station at the same time as the desired satellite; (2) adjacent channel interference originating from aircraft transmitters operating in the 118 to 136 MHz aeronautical mobile band which happen to be flying in the vicinity of the ground station; and (3) errors caused by broadband interference created by modulated signal sources or high voltage power lines. Analytical techniques are developed for use with the phase locked loop in the presence of interference. Three approaches are used: an infinite series solution to the linearized loop equation; a quasi-stationary approach to the effect of interference on the acquisition time and pull-in range of the phase locked loop; and phase plane solutions to the second order phase lock loops with interference. Series solutions are also included for first order and second order loops with carrier and interference present at the input. M.G.J.

N68-27665 Purdue Univ., Lafayette, Ind.
ON THE OPTIMIZATION OF MIXTURE RESOLVING SIGNAL PROCESSING STRUCTURES
William David Gregg (Ph.D. Thesis) 1967 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-10197

This thesis is concerned with the development of the structural form of optimum linear detection operators when the pulse waveform and noise parameters are unknown and are to be obtained by mixture resolving estimation; and with the development of the mixture resolving estimators to learn or extract this parametric information from the noisy signal pattern mixture, in order to obtain the elements for the structure. The observation signal model consists of a discrete, multidimensional, binary (two category) gaussian mixture. An eigenvalue approach is taken for the development of the structural form of the detection operator; the criterion of optimality being the minimum average conditional probability of error at the Nth stage, conditioned upon the mixture resolving estimating category. The mixture resolving categories developed consist of an optimized, time-varying-weighted decision-directed category and a moment method category. Extensive experimental studies, via digital computer simulation, of the performance characteristics of these signal processing algorithms are carried out. Dissert. Abstr.

N68-27726* Purdue Univ., Lafayette, Ind. Electronic Systems Research Lab.

ON THE STATISTICS OF CORRELATOR OUTPUTS

Paul A. Wintz [1966] 27 p refs Presented at the IEEE Intern. Conv. on Inform. Theory, 1966
(Grant NsG-553)
(NASA-CR-71559) CFSTI: $3.00 CSCL 09D

The characteristic function, probability density function, and probability distribution function for the output of the correlation detector were computed. These were found to depend on (1) the dimensionality of the vectors representing the input and reference waveforms; (2) the average of the energies of the signal components of the input and reference waveforms; (3) the inner product of the signal component vectors; and (4) the normalized cross-correlation coefficient of the like coordinates of the noise components of the input and reference waveforms. Also considered is system performance for the special case of identical signal components, but unequal signal to noise ratios, in the two channels. Author

N68-27732 Washington Univ., Seattle.

HIGH GAIN LOG-PERIODIC ANTENNAS

Yung-Sen Chen (Ph.D. Thesis) 1967 108 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-9904

One of the most challenging problems in the current antenna research is how to obtain a broadband high gain antenna. In recent years, many attempts have been made to increase the gain of the log-periodic type of frequency independent antenna. However, these attempts have met with limited success. It is postulated in this dissertation that the directive gain of a log-periodic antenna may be increased if the resonant elements are coupled electromagnetically to the transmission line. Two reasons for higher gain from the latter antenna are: (1) The use of weak coupling and slowly tapered resonant elements can be used to extend the active region to any desired length. (2) Depending on the size of the structure, two or more active regions may be operated simultaneously. Based on this idea, a magnetically coupled log-periodic antenna, which exhibits weak coupling between the resonant elements and transmission line, was proposed and built by the author. By proper design, one can (in principle) achieve arbitrarily high directivity by making the attenuation constant sufficiently small and the structure sufficiently long. Dissert. Abstr.

N68-27734 Mississippi State Univ., State College.

PROPAGATION RELIABILITY OF 2 GHz MICROWAVE SIGNALS AS A FUNCTION OF PATH LENGTH, GEOGRAPHICAL LOCATION, AND FADE MARGIN

Franklin Muranyi Ingels (Ph.D. Thesis) 1967 105 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9211

The research reported here was performed in three parts. A survey of the literature was conducted to become acquainted with all the work reported to date. A six-month experimental program was performed at an operating frequency of 2 GHz in order to obtain a statistical model of the effects of geographical location and path length upon the fade margin required to achieve a desired propagation reliability. This experimental program was conducted over nine microwave paths in the states of Louisiana, Mississippi, Alabama, and Kentucky. A set of equations was derived which allows calculation of the required fade margin for a given path, taking into account the variables of path length, geographical location, and propagation reliability. The experimental work performed resulted in a series of curves which show the fade margin required to achieve a desired propagation reliability over each of the nine paths which were monitored. The curves are plotted as fade margin required versus propagation outage time in order to expand the portions of the curves corresponding to high propagation reliability. Dissert. Abstr.

N68-27804 Cornell Univ., Ithaca, N. Y.

ON OPTIMUM RADAR RANGING CODES

James Rocco Caprio (Ph.D. Thesis) 1966 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-1452

The problem of selecting radar modulation waveforms possessing optimum autocorrelations for ranging purposes is examined. Two distinct types of signal autocorrelations are shown to be acceptable depending on whether the radar is operating in a search or track mode. To investigate the possibility of generating long codes with good track mode autocorrelations a pesudo-periodic method of code construction is developed. This technique of code generation is observed to be desirable from a practical point of view as well, since it is shown that pseudo-periodic codes are readily synthesized from a structure of cascaded link amplifiers. Huffman's non binary impulse-equivalent codes are examined in detail. Computer results are given which indicate that such phase codes yield optimum amplitude distributions. Dissert. Abstr.

N68-27819# New Hampshire Univ., Durham. Antenna Systems Lab.

THE RADIO INTERFEROMETER Scientific Interim Report

Albert D. Frost and Ronald R. Clark 20 Dec. 1967 60 p refs
(Contract AF 19(628)-5837)
(ASL-67-A; AFCRL-68-0062; SR-1; AD-668773)

The theoretical considerations involved in the operation of a radio frequency interferometer, in which the IF output signals from receivers at spaced sites are correlated by analog multiplication, is presented. The multiplier output can be resolved into plots of relative signal strength and phase; the latter being a function of the direction of arrival of the source wavefronts. A simple form of short baseline system in which the signal delay is under 3 microseconds and the fringe rate is less than 1 cycle per minute, is discussed. Through the introduction of a phase-locked offset in one of the intermediate frequencies it is possible to record the correlation output for later plotting or analysis. Author (TAB)

N68-27885 Johns Hopkins Univ., Baltimore, Md.

DIGITAL OPTIMIZATION OF EXPONENTIAL REPRESENTATIONS OF SIGNALS

Raymond Warrick Sears, Jr. (Ph.D. Thesis) 1967 138 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-9571

Before a signal, which exists as a continuous variation of a physical quantity, can be processed by a digital computer, it must be represented by a discrete finite set of numbers which can be handled algebraically by the computer. An iterative method for finding a suitable orthogonalized exponential basis has been investigated for the case in which a complete analytical or discrete description of the signals is available. The iterative method defines at each iteration a "trial basis" of orthogonalized exponentials which then provides an approximate discrete representation for the signals in the succeeding iteration. A suitable basis can thus be generated by a "bootstrap" process beginning with an initial trial basis which may provide only a poor representation. The process is terminated when no further improvement is obtained. Several ways of applying the basic method including application to an adaptive system are discussed. Several examples are presented to illustrate the use of orthogonalized exponential representations, and to demonstrate various features of the method and its applications. Dissert. Abstr.

N68-27899*# Ohio State Univ., Columbus. ElectroScience Lab.
THE REFLECTION COEFFICIENT OF A GROUND-PLANE MOUNTED TEM MODE PARALLEL-PLATE WAVEGUIDE ILLUMINATING A CONDUCTING SHEET
L. L. Tsai and R. C. Rudduck 24 May 1968 54 p refs
(Grant NsG-448)
(NASA-CR-66635; TR-1691-27) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The TEM (transverse electromagnetic) mode reflection coefficient is analyzed for a symmetric parallel-plate waveguide terminated in a ground plane and radiating into a perfectly reflecting sheet oriented normal to the guide axis. By using the wedge diffraction method the reflection from the conducting sheet is treated in terms of successive contributions or bounces that describe the interacting waves between the waveguide wedges and the reflector. Each of these bounce waves can be resolved into component cylindrical waves. The scattering of each of these component cylindrical waves by the guide produces two subsequent cylindrical waves. The geometrical optics component results from reflection from the ground plane and the aperture component represents the effect of the aperture in the ground plane, and total reflection from the sheet is obtained by summing these iterative contributions. The transmission between waveguides is a by-product of the reflecting sheet analysis. Calculated results are given for the transmission between two waveguides with each mounted in a ground plane and facing each other. Author

N68-27904# Douglas Aircraft Co., Inc., Tulsa, Okla. Modification Div.
A/RIA SYSTEM CATEGORY 2, VOLUME 1 Final Test Report
L. G. Hanscom Field, Bedford, Mass. Electron. Systems Div. Jul. 1967 404 p
(Contract AF 19(628)-4888)
(DAC-56171; ESD-TR-67-520, V. 1; AD-669102)

The A/RIA system is designed to provide voice and telemetry data communication with Apollo and other spacecraft, with a capability to relay all communications to the Manned Spaceflight Network, and record all telemetered data on board. The system includes a basic C-135A aircraft, modified to accept and support the electronics equipment and automatic tracking antenna required to perform the mission. The purpose of the Category II flight test program was to verify that the system could acquire and track an orbiting space vehicle--and trajectory of ballistic missiles--using VHF, UHF, and Unified S-Band frequencies, with simultaneous recording and two-way voice link with ground stations via HF. Quantitative system testing was performed at Douglas Aircraft, Tulsa, Okla.; operational evaluations included coverage of Gemini 12, a Polaris ballistic missile, and simulated Apollo coverage through use of a NASA C-121 Apollo Simulator. Author (TAB)

N68-27905# Michigan Univ., Ann Arbor. Dept. of Electrical Engineering.
SELECTED TOPICS IN AUTOMATA THEORY
Richard M. Karp Griffiss AFB, N. Y. RADC Apr. 1968 316 p refs
(Contract AF 30(602)-3546)
(RADC-TR-68-106; Rept.-06920-8-T; AD-669108)

Automata theory is a young mathematical discipline dealing with conceptual models of information processing devices and methods. It is the purpose of this report to give a formal development of the properties of some of these models, and to discuss their relationships to some possible areas of application. The main emphasis is given to the two most widely studied models: finite state machines and Turing machines. Other related models are briefly mentioned. Also included is a section which discusses the grammar and languages of mathematical linguistics and their connection to automata theory. Author (TAB)

N68-27918# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
A PROPOSED MODULAR ASSEMBLED ANTENNA EXPERIMENT FOR THE S4B WORKSHOP
Fred W. Forbes, Robert P. Huie, Steven D. Shook, James E. Crawford (Space Gen. Corp.), Earl G. Blackwell (Space Gen. Corp.) et al *In its* Expendable and Modular Struct. Conf. May 1967 p 1–22 refs (See N68-27916 16-32)

Described is a proposed experiment for determining the feasibility of manned assembled modular antenna structures in space. Objectives of the proposed space experiments are: (1) to demonstrate the technical feasibility of in-orbit assembly of structures, particularly an antenna or solar collector; (2) the development of cross validation zero gravity simulation techniques including underwater neutral buoyancy and zero gravity aircraft, especially with respect to assembly; (3) the determination of the relative contributions of manned assembly versus automatic deployed structure; (4) to obtain assembly data pertaining to antennas which can be extrapolated to larger structures; and (5) to obtain biomedical data on the assembly task by a suited subject in a pressurized and unpressurized mode. Presented is a concise summary of the background technology leading to the planning of the proposed experiment, a discussion of design parameters; and data on design, hardware status, and human factors aspects of the program. S.C.W.

N68-27929*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
FEASIBILITY DEVELOPMENT OF A SELF-DEPLOYING ELECTROMAGNETIC ENERGY FOCUSING REFLECTOR FOR SPACE OR TRANSPORTABLE GROUND BASED APPLICATIONS
William Korvin, Hossein Bahiman, and John Gates *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 237–253 (See N68-27917 16-32)

Materials and systems design concepts for a large aperture, lightweight, high gain, easily packaged and deployed parabolic antenna system having application in space and transportable tactical ground communications systems; are reported. The materials technique used is classified under the subheading of materials of the memory technique. This material consists of a fiber glass grid core covered with a thin flexible resin system plated by a metallic vacuum deposit which can be preformed in the desired shape, deformed into a packaged condition, and when released, because of its stored elastic strain energy, resumes its original fabricated contour. To implement this high modulus memory material approach for a practical design, a review of candidate material properties for the reflector design was carried out. Effort was started on the design and fabrication of a single piece, flexible, preformed mesh reflector. A mesh material configuration was chosen for its ability to form complex curves and to alleviate self-shrouding of the structure with solar radiation as well as reducing wind loads in possible ground use. Since the flexibility of a simple parabolic dish for packaging without degradation is not in keeping with the stiffness necessary (e.g. deployed configuration stability in a one g field), radial ribs of the same material were added. The parabolic dish was designed with marginal ability to maintain its preformed configuration without support as were the ribs; however, when assembled the composite structure became self-supporting. Included are data on radio frequency characteristics (primary and secondary pattern) of the system and a review of areas of possible material and design improvement. S.C.W.

N68-27933# Schjeldahl (G. T.) Co., Northfield, Minn.

UNFURLABLE ANTENNAS

A. J. Wendt and L. D. Surber *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 317–343 refs (See N68-27917 16-32)

Design and electrical test results for an inflatable cigar antenna, and an inflatable parabolic antenna are presented. The cigar antenna is basically a surface wave structure which uses circular disk elements to control the phase velocity of the radiated wave. In this respect, it closely resembles the Yagi–Uda antenna. Electrical and mechanical characteristics of the antenna are given. Electrical tests indicated that the gain of the cigar antenna was reasonably close to the theoretical value. Satisfactory radiation patterns were measured from 134 MHz to 225 MHz, a 1.68.1 bandwidth. Mechanical loading and deflection tests indicated that under zero internal pressure, the antenna structure can withstand a 0.02-g side load with a safety factor greater than two. It is concluded that the inflatable cigar antenna concept provides a very practical design approach to a medium gain VHF communications antenna for space application. Two 10-ft diameter inflatable parabolas were constructed having an f/D ratio of 0.833 and 0.42. The rms surface error on the shorter focal length model was 0.133, and approximately 1,000 on the longer focal length model. Radiation measurements were performed only on the shorter focal length model. Based on results obtained from electrical tests, it is concluded that: (1) the inflatable parabolic reflector is a very efficient antenna; (2) in a space application, the parabolic surface could be strain rigidized by pressurizing the antenna until the metal foil passes its yield point, and the same technique could be used to rigidize the feed support system; and (3) the rms surface error can be drastically reduced if a machined mandrel is used to form the parabolic surface. S.C.W.

N68-27940# Naval Research Lab., Washington, D. C. Radar Div.

AN UNFOLDING ANTENNA WITH MECHANICAL SCANNING SYSTEM FOR SATELLITE APPLICATIONS

James W. Titus *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 465–483 refs (See N68-27917 16-32)

A study designed to determine the feasibility of using relatively large antennas (apertures of about 24 feet) equipped for mechanical sector scanning in satellite applications is reported. The antenna is designed to be stowed folded inside an unpressurized vehicle or portion of a vehicle until time for deployment. The reflector consists of three panels hinged on each side of a small central panel, a total of seven parabolic panels. When the reflector is fully unfolded, the feed support together with the pedestal yoke form a rigid backbone providing a stable base line for the two telescoping struts and four stays which resist forces and moments. The antenna feed support, a length of L-band waveguide, is rigidly attached to the rotating part of the pedestal, as is a two piece yoke, to which is attached the center section of the reflector. Design details of the pedestal, yoke, and its associated linkage are given. Mechanical design problems related to antenna stowage, deployment, dynamic reactions on the vehicle, conservation of power, construction within dimensional tolerance, maintenance of these tolerances within the expected environment, and the accomplishment of these factors with a limited weight; are discussed. Also discussed are the potential of the proposed antenna system for operating at frequencies higher than L band, and antenna pointing control. On the basis of these studies it is concluded that: (1) the model as constructed meets design goals established by the requirements of an L-band search radar system; (2) the weight can be further reduced by careful refinement of the design of the parts; and (3) satisfactory S-band antennas can also be made in this range of apertures. S.C.W.

N68-27950# Aerospace Corp., El Segundo, Calif.

SELECTION AND DEVELOPMENT OF AN EXTENDIBLE, FLAT, CAVITY-BACKED SPIRAL ANTENNA

R. A. Farran and G. Yee *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 685–706 refs (See N68-27917 16-32)

A number of methods were investigated for fabricating flat, expandable, cavity-backed spiral antennas having expanded diameters of five to ten feet. The three general types considered were mechanical, expandable foam, and inflatables. Thirteen individual designs were evaluated for a particular space application, and a mechanical antenna having extendible arms was selected as best suited for this case. A simplified model having four radial arms was fabricated and tested, improvements were made, and the completed model was delivered to a contractor where a prototype flight model was fabricated. Author

N68-28063*# Techtran Corp., Glen Burnie, Md.

INFORMATION CAPACITY OF A PHOTON FIELD AND THE OPTIMIZATION OF OPTICAL SYSTEMS FOR INFORMATION TRANSMISSION [INFORMATSIONNAIA EMKOST' FOTONNOGO POLIA I OPTIMIZATSIIA OPTICHESKIKH SISTEM PERADACHI INFORMATSII]

I. A. Deryugin and V. M. Kurashov Washington NASA Jun. 1968 22 p refs Transl. into ENGLISH from the book "Kvantovaya Elektronika" Kiev, Izd. Naukova Dumka, 1967 p 229–246
(Contract NASw-1695)
(NASA-TT-F-11744) CFSTI: HC$3.00/MF$0.65 CSCL 09D

An examination is presented of the quantity of information which can theoretically be transmitted over a quantum channel, together with an analysis of methods for realizing the potential possibilities of optical information transmission systems. The problem consists of determining the influence of the statistics of laser emission on the information capacity and of relating the statistics of photoelectrons to actual communications systems using a photo detector. It is judged that the most useful states are ones having the smallest dispersion of photons, which determines the fluctuation of the photoelectrons in the receiving apparatus. Before the introduction of information, the photon field has a minimum dispersion which increases after the addition of information. Author

N68-28135*# Hughes Aircraft Co., Culver City, Calif.

STUDY OF ADVANCED ANTENNA TECHNIQUES FOR RENDEZVOUS RADAR

B. J. Forman, S. N. Vodopia, and W. H. Kummer Washington NASA May 1967 52 p refs
(Contract NAS1-2621)
(NASA-CR-764) CFSTI: HC$3.00/MF$0.65 CSCL 17I

A study of advanced antenna techniques for rendezvous and lunar landing radar systems is reported. The study was made in order to better define the antenna requirements for future manned spacecraft missions and to demonstrate the extent to which these requirements can be met within the present state-of-the-art. Recommendations have been made for antenna techniques that show promise in extending antenna technology. One such technique, which employs diode-irises to accomplish electronic-beam scanning, has been investigated and shown to be feasible. Technical material presented discusses results of the investigation on electronic scanning using diode-irises. The design and complete electrical performance of an X-band 10-element slot array is given. Included is a summary of a previous report which details the requirements to be met by antenna systems that are concerned with earth lunar missions which include lunar rendezvous, lunar landing, and earth rendezvous; and other promising antenna techniques whose development can be expected to provide enhanced performance and flexibility in over-all mission design. Author

N68-26272*# Systems Technology, Inc., Hawthorne, Calif.
AN EXPERIMENTAL INVESTIGATION OF COMPENSATORY AND PURSUIT TRACKING DISPLAYS WITH RATE AND ACCELERATION CONTROL DYNAMICS AND A DISTURBANCE INPUT
R. W. Allen and H. R. Jex Washington NASA Jun. 1968 77 p refs
(Contract NAS2-3746)
(NASA-CR-1082; TR-170-1) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Four instrument-rated pilots were trained and tested with a series of different tracking displays and controlled element dynamics to validate some anomalous previous experiments and to provide a sounder data base for a theory of manual control displays. Quasi-random (sum of 9 sinusoids) inputs were used. Compensatory (C) and pursuit (P) display modes were investigated along with a hybrid pursuit-plus-disturbance (P+D) display mode. For P+D the command input was displayed conventionally, while a separate, uncorrelated disturbance input was applied to the controlled element. Rate control and acceleration control dynamics were investigated. The training data show that all pilots learned quickly to perform about equally well with all displays when controlling rate dynamics. With acceleration dynamics they took much longer to learn and the results showed more variability. In the main experiment, the error performance was not sensitive to display mode, while the describing function data showed that differences in the pilot's behavior did occur, with opposing effects leading to the constant net error. Author

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N68-26889# Logicon, Inc., Redondo Beach, Calif.
COMPARATIVE EVALUATION OF PL/1 Final Report, Aug. 1967–Feb. 1968
Raymond J. Rubey et al Bedford, Mass. AFSC, Electron. Systems Div. Apr. 1968 290 p
(Contract F19628-67-C-0396)
(CS-6813-R0106; ESD-TR-68-150; AD-669096)

Seven benchmark problems were each implemented twice by the same programmer, once in PL/I and once in another higher level language (COBOL, FORTRAN, or JOVIAL) appropriate to the application area represented by the problem. Overall, it was found that PL/I had advantages over both FORTRAN and JOVIAL and was about equal to COBOL for the respective application areas. The quantitative data obtained from the implementations generally indicated that the PL/I versions had fewer statements in the source programs and were coded more rapidly than their comparison-language counterparts but took longer to debug and had a higher frequency of errors. The qualitative, subjective opinions of the problem programmers and project analysis indicated that PL/I was generally superior to the comparison languages with regard to suitability for a wide range of problems, naturalness, generality, and ease of use. Inefficiencies observed in the language compilers and associated operating systems utilized for the benchmark problems indicated that improvements are required in these areas if the benefits obtainable from the use of higher level languages are to be fully realized. Author (TAB)

N68-26999# National Bureau of Standards, Washington, D. C. Center for Computer Sciences and Technology.
COMPUTER/DISPLAY INTERFACE STUDY Quarterly Report, 1 Jul.–31 Dec. 1966
Paul Meissner Ft. Monmouth, N. J. Army Electron. Command Jan. 1968 38 p
(ECOM-95829-2; QR-2; QR-3; AD-668934)

This second and third quarterly report describes the progress of the Computer/Display Interface Study for this period. Intercommunication between MAGIC and MOBIDIC has been implemented including executive routines for both machines. The design features of MAGIC II were reviewed. A color display oscilloscope (19-inch rectangular shadow mask tube with 10-by-10 inch viewing area) was obtained on loan and interfaced to MAGIC I. The improvement due to the addition of color was clearly demonstrated. Author (TAB)

N68-27005# Carnegie-Mellon Univ., Pittsburgh, Pa.
A METHODOLOGY FOR EVALUATING TIME-SHARED COMPUTER SYSTEM USAGE
Michael M. Gold Aug. 1967 151 p refs
(Contract ARPA SD-146; Nonr-4102(01))
(AFOSR-68-0795; AD-668084)

The development of time-shared computer systems has led to major technical and philosophical changes in the computer field in this decade. A large number of designers, manufacturares, and users of such systems have expended great amounts of effort in the development of the capabilities of the computer and the means to use it. However, little or no effort has yet been expended to evaluate these systems in terms of their usefulness for present or future customers. The research reported here has focused on the development of a methodology through which time-shared computer system usage can be evaluated. It is based on a study of the characteristics and design of present and proposed computer systems, as well as relevant behavioral theory and research. Five categories of variables are included in the resulting methodology, namely those which are measures of: (1) the cost of using the system; (2) the performance produced through the use of the computer system; (3) the speed with which results could be produced; (4) the amount of learning resulting from the use of the computer system; and (5) the attitudes of the users of the computer system. Author (TAB)

N68-27061# Carnegie Inst. of Tech., Pittsburgh, Pa.
***1 MANUAL**
Allen Newell, Jay Earley, and Fred Haney 26 Jun. 1967 19 p refs
(Contract ARPA SD-146)
(AFOSR-68-0938; AD-669134)

*1 is a set of system 360 macros designed to perform the basic tasks that appear in many list processing and systems programming applications. It is based on L6, a list processing language designed by K. Knowlton. According to Knowlton, the purpose of L6 was to permit users to get much closer to machine code in order to write faster running programs, to use storage more efficiently, and to build a wider variety of data structures. The goals of *1 are approximately the same. One objective in the design of *1 was to give the programmer control over the code that is produced. This is accomplished by making the internal workings available to the user and allowing him to alter any of the internal macros for his own use either directly or by using the meta-language. *1 provides two basic data structures, the block and field, which may be compounded into arbitrarily complex high-level data structures. Data within these structures is referenced by indexing or by chains of pointers which lead to desired storage locations. The data comparisons and tests, control operations, and input/output operations. Author (TAB)

N68-27100# System Development Corp., Santa Monica, Calif.

SYSTEM ENGINEERING GUIDE FOR COMPUTER PROGRAMS

Lloyd V. Searle and Robert L. Henderson Bedford, Mass. AFSC, Electron. Systems Div. Mar. 1968 174 p
(Contract F19628-67-C-0128)
(TM-3596; ESD-TR-68-1; AD-669129)

This report discusses the application of system engineering principles to the development of computer programs and associated elements of large systems. Using the road map approach and basic concepts established by the Air Force, it describes step-by-step events during the conceptual, definition, acquisition, and operational phases of a system life cycle. Technical milestones in system computer program analysis, design and developments are identified and related to associated activities and requirements in the areas of test and evaluation, configuration management, data management, and human factors. Procedures outlined in the guide are based on experience with a number of large electronic systems developed for the Air Force. Emphasis in the description is placed on aspects of the technical process which have significant implications for system program planning and management. Author (TAB)

N68-27120# Harvard Univ., Cambridge, Mass. Center for Environmental Design Studies.

A TWO-DIMENSIONAL INTERPOLATION FUNCTION FOR COMPUTER MAPPING OF IRREGULARLY SPACED DATA

Donald Shepard 20 Mar. 1968 21 p refs
(Contract N00014-67A-0298-0004)
(TR-15; AD-668707)

Techniques of interpolating from irregularly spaced known function values in two dimensions are discussed. First, a function defined as a weighted average of the given function values, with the weighting based on the inverse distance from the corresponding points, is explored. To shorten computation and improve the quality of interpolation, additional terms based on distances, directions and slopes are added. An interpolation function everywhere continuously differentiable and fitting the data exactly is finally presented. A provision for barriers to interpolation is described for applications in geographical analysis. The interpolation function has been incorporated into a computer mapping program in FORTRAN called SYMAP (Versions IV and V). Author (TAB)

N68-27121# Melpar, Inc., Falls Church, Va.

COMPUTER ROUTINES FOR DETERMINING MODEL COORDINATES FROM ANGLE MEASUREMENTS—A STUDY OF RANDOM NETWORK MODELS

Fred Ordway Apr. 1968 82 p refs
(Contract N00014-67-C0258)
(TR-3; Rept.-6353-00200; AD-669126)

Angle measurements are made with a surveyors transit (theodolite) to determine coordinates of centers and vertices in a tetrahedral network model. These measurements on the model, and also on a set of fixed calibration points, are made from two transit positions. In addition, the distances between a number of pairs of calibration points are carefully measured and the distance from the transit center in each position to each of the calibration points is measured approximately. Calculation of coordinates involves three computational steps: (1) refining the approximate calibration point-transit distances; (2) determining the rotation-translation matrix relating the coordinate systems defined by the two transit positions; and (3) calculating coordinates of all points from the angle data. The calculation is done as previously outlined, except that three rotational parameters are adjusted in each refinement of the matrix in step (2). Computer routines for the three steps, and for the preliminary correction of elevation angles, are given in FORTRAN IV. Author (TAB)

N68-27125# Adams (Charles W.) Associates, Inc., Bedford, Mass.

INVESTIGATION OF M460/340 DISPLAY TECHNIQUES Final Scientific Report, Feb. 1966–Feb. 1968

Roy M. Salzman, Frank S. Greatorex, Alain F. Grebert, Stephen I. Cohen, John S. Hermistone et al May 1968 22 p
(Contract AF 19(628)-5894)
(AFCRL-68-0146; AD-668544)

This final report contains a summary of the three major areas of effort: (1) development and implementation of a generalized display package whose specifications were formulated under contract, (2) the TECO program interfaced with the scope handling routines to permit text editing via the 340 scope, and (3) necessary system modifications to produce a device-independent modularized operating system. Author (TAB)

N68-27206# Argonne National Lab., Ill. Applied Mathematics Div.

APPLIED MATHEMATICS DIVISION SUMMARY REPORT, JULY 1, 1966 THROUGH JUNE 30, 1967

Wallace Givens 1967 90 p refs
(Contract W-31-109-ENG-38)
(ANL-7418) CFSTI: HC$3.00/MF$0.65

A summary is presented of computer programs that were completed during the period. Also presented are summaries of activities in programming research and development, numerical and mathematical analysis, computer utilization in divisional research, computer engineering and computer systems, Argonne code center, and digital computer operations. Listings are included of publications, papers, seminars, and symposia. NSA

N68-27227# Electronic Associates, Inc., Princeton, N. J. Computer Center.

RESEARCH AND DEVELOPMENT OF PARALLEL HYBRID MODELS

Ronald M. Maslo ed. 15 Mar. 1968 284 p refs
(Contract AF 19(628)-5043)
(AFCRL-68-0147; SR-3; AD-669107)

In a program of research and development of simulation models for the Air Force Cambridge Laboratories, the contractor has studied methods for establishing computer models for problems submitted by laboratory scientists and Data Analysis Branch mathematicians and implemented them for solution on the AFCRL Parallel-Hybrid Computers. Eighteen problems were submitted during the year. They were from the fields of electromagnetic ray propagation, mathematics, orbital mechanics, space physics, dynamics and circuit design. Significant results were obtained in twelve of the problems. The remaining six problems are under continued study. Author (TAB)

N68-27310# Mitre Corp., Bedford, Mass.

USING THE READILY AVAILABLE ALGEBRAIC LANGUAGE AS A COMPILER ENVIRONMENT

Gilbert P. Steil, Jr. Apr. 1968 66 p refs
(Contract AF 19(628)-5165)
(MTR-516; ESD-TR-67-430; AD-669092)

The use of algebraic command languages for things other than preparing numerical algorithms has become somewhat popular, in particular for writing compilers. This technique will be found particularly useful by organizations not in the business of building commercial compilers, but interested in the implementation of a small special-purpose language, such as a query language for a model of a command system. The purpose of this paper is to describe this technique to such an audience and to comment on the extent of its applicability. Author (TAB)

N68-27347# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CONVERSION OF GRAPHS INTO ELECTRICAL SIGNALS

A. I. Petrenko 29 Aug. 1967 197 p refs Transl. into ENGLISH of the book "Preobrazovaniye Grafikov v Elektricheskiye Signaly" Kiev, 1964 p 1–219

(FTD-MT-65-391; AD-668517)

This book presents the principles of the theory, construction, and circuits of converters of graphs of functions of one or two variables into electrical signals with the same law of change overtime as the converted function. The equipment that is described is used to automate the input of graphic information into an electronic computer, for the generation of pulses of any shape, and as indicators of nonlinear relationships in electric modeling, in program control systems, and in physics experiments. The book is intended for engineers and researchers working in radio electronics and can also be used by students in electrical and radio engineering faculties. Author (TAB)

N68-27625 Washington Univ., Seattle.

MACHINE RECOGNITION OF GEOMETRIC PATTERNS

John Albert Newell (Ph.D. Thesis) 1967 137 p

Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-9391

Automatic processing of data contained in graphical displays requires the use of some form of geometric pattern recognition equipment. A typical installation would require a scanning device, an optical-electrical interface, and a machine capable of interpreting the electrical data thus obtained. This dissertation investigates some existing methods of geometric pattern recognition and suggests a method which is superior to existing methods in some respects. Functions of the joint central moments of order zero through four which are invariant to translation, similitude, and orientation are developed and tested. A pattern separation program is obtained to accommodate several distinct patterns in one field of view. Dissert. Abstr.

N68-27689 Pittsburgh Univ., Pa.

FREQUENCY TECHNIQUES, REDISTRIBUTION AND THE STORAGE CAPABILITY OF SECONDARY EMISSION DEVICES

Alvise Braga-Illa (Ph.D. Thesis) 1966 145 p

Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-9737

A unified approach to the utilization of secondary emission tubes as digital memory devices, in applications requiring either continuous or discontinuous scanning, is presented. The devices considered operate with electron beams whose energies are high enough to cause the secondary emission coefficient to exceed one. Specifically, this study deals with the so-called barrier grid and mesh collector tubes. The central result of the paper is that the resolution of a secondary emission tube can be characterized by an equivalent, or effective, current distribution in the beam. A frequency response technique is introduced to measure the equivalent current distribution. The frequency response of the memory device is defined for this purpose as the ratio of the peak-to-peak output current during the reading cycle to the peak-to-peak value of the input current during the writing cycle. Dissert. Abstr.

N68-27777# Washington Univ., St. Louis, Mo. Computer Systems Lab.

DEVELOPMENT OF AN ON-LINE IMAGE PROCESSING SYSTEM FOR THE LINC

John E. Guignon, Jr. and Raymond M. Kline Feb. 1968 133 p refs

(Contract ARPA SD-302; Grant NIH FR-00218)

(TR-5; AD-668966)

The development of an on-line image processing system for the LINC computer is described with both hardware and software details being considered. The purpose of the system is to operate on various types of optical images endeavoring to process them so that a maximum amount of useful information is retrieved for final interpretation by the observer. Besides other processing techniques, contrast enhancement and subtraction have been implemented into the system to achieve this purpose. A mathematical model of the system is investigated and equations describing its capabilities are derived. Results showing several pictures before and after processing as well as data verifying the mathematical model are also presented. Author (TAB)

N68-27970# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.

GENERALIZED LINEAR REGRESSION ANALYSIS

F. Delano Knight Feb. 1968 26 p

(Contract AT(07-2)-1)

(DP-1128) CFSTI: HC$3.00/MF$0.65

A generalized computer program developed to fit selected functions to experimental data by the method of least squares is described. This program is characterized by a wide selection of functional forms for the independent and dependent variables, an extensive listing of descriptive statistics, and a simple input form that facilitates program use. Author (NSA)

N68-27983# Stanford Univ., Calif. Linear Accelerator Center.

A COMPUTER-CONTROLLED SYSTEM FOR MEASURING BUBBLE CHAMBER AND SPARK CHAMBER FILM

M. Jensen, F. Martin, E. Mueller, and B. Salsburg Jan. 1968 16 p ref

(Contract AT(04-3)-515)

(SLAC-81) CFSTI: HC$3.00/MF$0.65

A computer-controlled manual measuring system for measuring spark chamber and bubble chamber film, designed and constructed at SLAC is described. The basic components of this system are the ASI 6020 computer, the control program BUCAPS, and the high precision measuring projector with its control electronics. NSA

N68-27987# Gulf General Atomic, San Diego, Calif.

DESCRIPTION OF PROGRAM DFCTAV AND THE DEFECT MODEL WHICH IT IS DESIGNED TO SOLVE

J. F. Colwell 7 Jun. 1967 15 p refs

(Contract AT(04-3)-167)

(GAMD-8026) CFSTI: HC$3.00/MF$0.65

A model for defects in irradiated graphite based on equations of Woolley modified to include vacancy lines is presented. A method for integration of these equations and a FORTRAN computer program are described. NSA

N68-27994# Wyle Labs., Inc., Huntsville, Ala.

DATA HANDLING METHODS FOR LARGE VEHICLE TESTING

Daniel J. Bozich *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 77–87 refs (See N68-27989 16-32)

Environmental testing of large aerospace vehicle structural systems requires a great number of measurements to describe adequately the response of the vehicle system to simulated environments. These environmental control and response measurements comprise the full range of acoustic, aerodynamic, vibration, and thermal parametric relationships. Analog-digital data acquisition computer systems and digital data reduction techniques have made practical the large-scale data processing tasks associated with several hundred response measurements acquired on line from a single test. Several techniques for acquiring periodic (sinusoidal), random, and aperiodic (transient) response signals in real time utilizing on-line analog-digital computer systems are reviewed, along with the associated digital data reduction methods. Existing systems and their capabilities are discussed. Spectral densities and three-dimensional resonant mode shape plots are a few of the examples shown of digitally produced information from test data. Recent developments in hardware and software techniques, which promise to revolutionize the application of computers to large vehicle testing, are discussed. Included is a preview of the use of special integrated-circuit hardware and the use of the fast Fourier transform (FFT) method for analyzing data. Author

N68-28040# Douglas United Nuclear, Inc., Richland, Wash.
FORTRAN PROGRAMMING
P. D. Gross Jan. 1968 160 p
(Contract AT(45-1)-1857)
(DUN-2400)

The computer programming language FORTRAN IV is described. How data are stored and transferred within the basic elements of the computer is discussed. The structure and use of the various basic elements which make up the FORTRAN language itself are examined. Examples are included to demonstrate or clarify usage of these elements wherever necessary. Techniques in setting up an application for programming (flowcharting) and in debugging a program once it has been written are considered. NSA

N68-28182# California Univ., Livermore. Lawrence Radiation Lab.
DEDICATED COMPUTERS FOR INSTRUMENT CONTROL
Roger E. Anderson 15 Mar. 1968 14 p refs Presented at Conf. on Digital Equipment Computer Use, Maynard, Mass.
(Contract W-7405-ENG-48)
(UCRL-70638; CONF-671130-1) CFSTI: HC$3.00/MF$0.65

The low-cost control computer can be readily interfaced to laboratory instruments by using breadboard circuitry. This paper describes several such applications using the PDP-8/S. Emphasis includes software techniques, system capability and versatility, and experimenter interaction. These systems are discussed as an alternate to a larger time-shared system. Specific examples are used to illustrate this philosophy. Author (NSA)

N68-28216# Atomic Weapons Research Establishment, Aldermaston (England).
MANUAL FOR THE S2 AND S3 DIALECTS OF FORTRAN 2
Mary V. Thomas, ed. Mar. 1968 93 p ref
(AWRE-O-59/67) CFSTI: HC$3.00/MF$0.65

The S2 compiler operates on the IBM 7030 (STRETCH) and the S3 compiler operates on the ICT ATLAS 2 and both accept a dialect of FORTRAN 2. These dialects are termed S2 and S3 and are described in the present manual which is a revision and amplification of the "Manual for the S2 Language". Author

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N68-26961# Army Electronics Command, Fort Belvoir, Va.
EFFECT OF COLLECTOR DESIGN ON HOT-SPOT FORMATION AND SECOND BREAKDOWN IN TRANSISTORS
Bernard Reich and Edward B. Hakim Feb. 1968 15 p refs
(ECOM-2943; AD-668903)

Hot-spot formation was studied as a function of collector resistivity and thickness variations for a similar group of epitaxial and triple-diffused silicon planar transistors. An infrared radiometer was used for locating and measuring hot-spot temperatures. Hot-spot thermal resistance is used in the analysis of both forward and reverse bias second breakdown performance. Author (TAB)

N68-26982# Naval Civil Engineering Lab., Port Hueneme, Calif.
SCHOTTKY EMISSION IN THIN FILM DIODES
R. D. Hitchcock Apr. 1968 26 p refs
(R-575; AD-668694)

Temperature-dependent current-voltage (I-V) characteristics was observed in a new type of thin-film diode, consisting of Al, Al2O3, Mn, MnxOy, and Pb. Plots of ln I-V to the 1/2 power, d ln I/dV to the 1/2 power - 1/T, and ln(I/sq T) - 1/T (where T is temperature in K) can be fitted by straight lines which show that Schottky emission is the dominant current-flow mechanism over the temperature range of 190K to about 350K. Barrier thicknesses were determined by high-frequency capacitance measurements and found to lie between 100A and 250A. Relative work functions, between the aluminum and lead films, were found to lie between 0.25 and 0.50 ev. One of the diodes was tested at 60 Hertz for 124 hours without causing a significant change in the shape of the I-V characteristic. It is concluded that nominal refinement of the fabrication technique will lead to a varistor thin-film diode which is inexpensive and which has long-term stability. Author (TAB)

N68-26996# Army Electronics Labs., Fort Monmouth, N. J. Electronic Components Lab.
RELATIONSHIP BETWEEN HOT-SPOT FORMATION AND SECOND BREAKDOWN IN TRANSISTORS
Bernard Reich and Edward B. Hakim Feb. 1968 19 p refs
(ECOM-2944; AD-668902)

By the application of an infrared radiometer as the sensor, hot-spot formation is detected and a hot-spot thermal resistance is calculated. Hot-spot formation for both forward and reverse biased second breakdown is analyzed. Pulsed DC techniques are used in the investigation which allows for a wide range of possible operating biases to be applied. Author (TAB)

N68-27013# Hughes Research Labs., Malibu, Calif.
MAGNETIC COMPRESSION OF ELECTRON BEAMS
Quarterly Technical Report, 1 Oct.–31 Dec. 1967
Kurt Amboss May 1968 18 p refs
(Contract DA-28-043-AMC-01463(E))
(ECOM-01463-9; Rept.-9; QR-9; AD-668904)

The objective of this program is to compress an electron beam by a factor of 1000 and to gain an understanding of the behavior of the beam. The experimental approach involves the probing of a scaled-up beam in suitable magnetic fields and the subsequent demonstration of compression in a sealed-off tube with a beam of the correct size. The theoretical approach has been to extend the linear optical theory to include nonlinear effects. Author (TAB)

N68-27070# Sandia Corp., Albuquerque, N. Mex.
A FABRICATION PROCESS FOR CLOSE-TOLERANCE, MULTILAYER, PRINTED-WIRING BOARDS Laboratory Manual
A. D. Andrade Feb. 1968 94 p refs
(Contract AT(29-1)-789)
(SCL-DC-67-80) CFSTI: HC $3.00/MF $0.65

A step-by-step outline of a technique used in the fabrication of multilayer printed-wiring boards is given. The process produces low-cost, close-tolerance, reliable boards, and does it by making maximum utilization of the advanced numerically controlled equipment that is now becoming available. Author (NSA)

N68-27076# Autonetics, Anaheim, Calif.
RADIATION EFFECT ON THIN FILM INTEGRATED CIRCUIT ELEMENTS Final Report, 15 Oct. 1966–14 Oct. 1967
Virgil H. Strahan, Ross A. Williams, Albert F. Krueger, Donald K. Nichols, and Albert J. Chesavage Apr. 1968 45 p refs
Sponsored by DASA
(Contract DA-28-043-AMC-02431(E))
(ECOM-02431-F; Rept.-9; AD-668257)

The charge change seen by a thin-film conductor deposited on a substrate due to electrons scattered from the substrate by incident X rays was investigated both experimentally and theoretically. Targets consisting of thin-film aluminum conductor patterns were deposited on alumina, glass, and mica substrates and irradiated with photons from 600 keV and 2 MeV pulsed flash X-ray units and with both bremsstrahlung and 18 MeV electrons from a linear accelerator. It was found that electrons scattered from the substrate were emitted in two energy groups, one with energies less than 100 eV and one with energies of the same order of magnitude as the incident photon energy. The charge change seen by the conductor was found to be the result of scattering of electrons from the target by the incident photons and absorption by the target of electrons scattered from materials between the target and the photon source. The absorption or emission of the low energy electrons can be controlled by altering the potential on the target. The dependence of the charge scattering effect on photon energy conductor area, and target thickness was measured. The charge seen by the conductor was found to be proportional to the conductor area in the absence of fringe fields and to be an increasing function of substrate thickness. Theoretical calculations were made for the high-energy component of charge scattering for both thick and thin targets. This was found to be of the same order of magnitude as the high-energy component for the 600 keV X rays and to decrease relative to the high-energy component with increasing energy. The theoretical calculations of the high-energy component covered the photon energy range from 0.05 to 20 MeV. Author (TAB)

N68-27077# International Business Machines Corp., Oswego, N. Y. Electronics Systems Center.
GALLIUM-PHOSPHIDE LIGHT-EMITTING DIODE ARRAY Final Report, 1 May–30 Nov. 1967
Henry C. Farrell and Robert J. Lynch Apr. 1968 39 p
(Contract DAAB07-67-C-0407)
(ECOM-0407-2; Rept.-67-928-92; AD-668668)

The goal of this program was to provide the United States Army Electronics Command with a versatile experimental display module using gallium-phosphide (GaP) light-emitting elements. The potential advantages of a solid-state display over other presently used displays are its light weight, small volume, low-voltage operation, and long life. The module design resulting from this effort employs 60 individually mounted gallium-phosphide diodes arranged in six parallel rows of 10 diodes each. Each diode is addressed by means of associated control circuitry which provides coincident cross-grid access and the means for diode latching in the conductive or nonconductive state. The format for addressing X and Y grids may be analog, using voltage amplitude, or digital, using a binary-coded decimal (BCD). Either line scan or random access may be used for displays with this diode array. Author (TAB)

N68-27151# ITT Industrial Labs., Fort Wayne, Ind.
INVESTIGATION OF STRONTIUM TUNGSTATE MIXED CRYSTAL CATHODE Final Report, 26 Aug.–27 Dec. 1967
Bernard W. Byrum, Lozure G. Wolfgang, and J. L. Gumnick Apr. 1968 50 p refs
(Contract DAAB07-67-C-0381)
(ECOM-0381-F; AD-668685)

The purpose of the work described is to investigate the formation and characteristics of tungstate mixed crystal cathodes. The objective is the realization of a lower work function in a relatively rugged cathode. Richardson plots and retarding field electron beam techniques were used to evaluate the work function of sample cathodes. The final set of experiments, done in individual tubes, utilized the zero field value of current for the Richardson data where possible. The zero field values were taken from Schottky plots of the I-V data. All cathodes have been made by spraying the mixed materials onto the metallic substrate. Tantalum was abandoned as a substrate due to adherence problems. Tungsten substrates have been used for high temperature processing. P-50 nickel alloy substrates were used to eliminate adherence problems and reduce activation variables to a minimum. Author (TAB)

N68-27203*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH ENERGY PROTON TESTING OF MARINER 4 COMPONENTS
Bruce E. Anspaugh 1 Jan. 1967 35 p refs
(Contract NAS7-100)
(NASA-CR-95148; JPL-TM-33-314) CFSTI: HC $3.00/MF $0.65
CSCL 09A

The following Mariner 4 components were irradiated with 20 to 137 Mev protons from the Harvard synchrocyclotron: (1) Canopus tracker, (2) data encoder, (3) squibs, (4) batteries, (5) solar cells, (6) central computer and sequencer circuitry, (7) sun sensor, (8) semiconductor devices and integrated circuits. Flux rates used varied between 5×10^4 and 3×10^7 protons/cm^{2}sec. All tested units were irradiated to an integrated flux of at least 2×10^{10} protons/cm^2. All components, except the solar cells and Canopus tracker, operated normally during irradiation. The power output of the solar cells permanently dropped to approx. 85% of the pre-irradiation value but was less than the predicted power loss. The tracker lost roll control at flux rates greater than 6×10^5 protons/cm^2 sec for energies greater than 40 MeV, but recovered tracking ability immediately when the beam cut off, even after an integrated flux of 2.4×10^{10} protons/cm^2. Consequently, a high energy, high intensity solar flare could degrade tracker operation to a marginal region, but the system will recover after the flare. The tracker sensitivity was found to be due to an induced radioactivity in the image dissector tube. Author

N68-27304# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELECTRONIC DEVICES [ELEKTRONNUUE PRIBORY]
N. D. Devyatkov *In its* Radio 70 Yr. 30 Jun. 1967 p 333–348
(See N68-27287 16-07)

A recitation of electronic devices developed over the years which have enhanced all fields of radio and electronics is presented. Included in the list, with brief discussions of each item are: receiving and transmitting tubes, electrovacuum SHF instruments, (triodes and diodes), klystrons, magnetron type instruments, traveling-wave tubes, carcinotrons, and gas-discharge instruments.
Author

N68-27307* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PHENOMENOLOGICAL STUDY OF RADIATION DAMAGE AND RECOVERY OF METAL-OXIDE FIELD EFFECT TRANSISTORS

U. D. Desai, R. L. Van Allen, and J. L. Wolfgang, Jr. [1966] 13 p Presented at the IEEE Ann. Conf. on Nucl. and Space Radiation Effects, Palo Alto, Calif. 18–22 Jul. 1966 Submitted for publication
(NASA-TM-X-5752) CFSTI: $3.00 CSCL 09A

Radiation damage and modes of the recovery process of metal oxide field effect transistors are investigated. Only p-channel enhancement mode devices were studied and the source of radiation was a 1.5 MeV electron beam. All samples tested were first damaged with irradiation and then their electrical characteristics recovered by either thermal annealing through four cycles, or by heating to a temperature (280°C) so that even at zero gate voltage the unit was saturated and current between drain and source was limited with external resistance to 100 μA. Most of the observations in this study of degradation and recovery could be explained on the basis that ions are trapped in the surface states at the interface of Si and SiO_2. These ions are generated by the radiation in the SiO_2, migrate and become trapped in these surface states. Further, the ions are relatively immobile and counteract the field applied at the gate electrode which is attempting to form the channel.
A.L.

N68-27638*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PROTON IRRADIATION EFFECTS IN MOS JUNCTION FIELD-EFFECT TRANSISTORS AND INTEGRATED CIRCUITS

Floyd R. Bryant, Carl L. Fales, Jr., and Roger A. Breckenridge [1966] 35 p refs Presented at the 5th Ann. Symp. on the Physics of Failure, Columbus, Ohio, 15–17 Nov. 1966
(NASA-TM-X-59313) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Because of the application of field-effect transistors, and integrated circuits in space electronic systems and the fact that proton irradiation data at energies typical of a space environment are not extensive, an experimental evaluation of these devices was conducted. The important electrical parameters of these devices were measured before, during, and after irradiation by a 22-MeV cyclotron. The results obtained from the MOS field-effect study show that their degradation processes include that of charge storage in the silicon dioxide insulating layer and radiation-induced changes in surface states. MOS transistors were found to degrade at orders of magnitude less integrated proton flux than many bipolar and junction field-effect transistors; therefore, for space applications in radiation fields such as Van Allen Belts and solar particle events, these devices may be subject to serious radiation damage.
Author

N68-27654 Minnesota Univ., Minneapolis.

THE CHARACTERIZATION OF THE STATIC BEHAVIOR OF PN JUNCTION DEVICES

David Edgar Fulkerson (Ph.D. Thesis) 1967 132 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-10411

The static behavior of certain PN junction devices that are governed by Van Roosbroeck's differential equations were examined. It is found that this set of first order differential equations (in the hole and electron concentrations, hole and electron current, electric field, and voltage) predicts a wide variety of observed semiconductor behavior. The purpose of the model is no less than to find all of the above variables as functions of position and external excitation. Devices in equilibrium, i.e., with no external excitation were dealt with first. Boundary conditions and some approximations that can be made for the characterizing differential equations were studied next. A simple model for the dependence of transistor current gain on collector current was discussed.
Dissert. Abstr.

N68-27786 Minnesota Univ., Minneapolis.

The BaO–Ni MATRIX CATHODE FORMED BY THE NICKELATE TECHNIQUE

Theodore Joseph Szczech (Ph.D. Thesis) 1967 120 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-10444

A rugged matrix type cathode with good thermionic emission may be produced by indirectly heating a mixture of $BaCO_3$ and NiO in a weight ratio of 1:3 on a pure Ni base. Heating at a pressure below 10^{-4} Torr results in decomposition of the $BaCO_3$ to BaO and CO_2 which is pumped off. The BaO combines rapidly with the NiO above 900°C to form barium nickelate, NiO·BaO. The cathode is heated to 1250°C, resulting in a melt of the NiO·BaO, NiO mixture and a subsequent sintering of the substances to the Ni base upon cooling. Composition of the cathode at this stage was determined using X-ray diffraction techniques. The processing is completed by heating the cathode to 800°C in flowing hydrogen gas for a period of ten minutes. The performance of the cathodes was determined from thermionic pulse emission studies in a vacuum of about 5×10^{-9} Torr. Photoemission measurements were made to determine the total yield at room temperature for photon energies ranging from threshold to 5.5 eV. In order to determine the distribution of the BaO particles in the Ni matrix, several cathodes were studied with an electron microprobe. A theoretical analysis of the hydrogen reduction process is presented. Chemical kinetic theory is used in the development of one model and diffusion theory in another.
Dissert. Abstr.

N68-27886# Varian Associates, Palo Alto, Calif.

A DEVELOPMENT PROGRAM TO IMPROVE THE BROADBANDING OF HIGH POWER AMPLIFIER KLYSTRONS Quarterly Progress Report, 15 Oct.–30 Dec. 1967

Louis Zitelli Jan. 1968 105 p
(Contract DAAB07-68-C-0080)
(Rept.-357-1Q; Rept.-1; QPR-1; AD-668693)

Effort was confined to comparing performance of an existing X-band klystron with computed results and to becoming knowledgeable in the design of coupled cavity output circuits.
Author (TAB)

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N68-27043# Royal Aircraft Establishment, Farnborough (England).

COMPUTER AIDED ANALYSIS OF A LOW FREQUENCY BAND-PASS ACTIVE FILTER

G. May and G. Brown Dec. 1967 42 p refs
(RAE-TR-67315)

The design of a simple active band-pass filter using a linear integrated circuit module is discussed. The application of matrix algebra, the R.A.E. nodal-analysis computer program and the Benson-Lehner plotter to the simplification of the circuit design work is described. Practical limitations to the use of the computer program due to the non-availability of data in the form of active device parameters are mentioned. Author

N68-27135# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AUTOMATIC ADJUSTMENT AND CONTROL (CHAPTERS 5-8)
Ye. P. Popov 27 Sep. 1967 137 p refs Transl. into ENGLISH from the book "Avtomaticheskoye Regulirovaniye i Upravleniye" Moscow, Izd. Nauka, 1966 p 182-382
(FTD-MT-24-127-67; AD-668927)

Chapter five deals with the statistics of random processes, scattering, continuous random values, and error estimates in random process. The basic formulas of statistical inference are presented and several examples are given. Chapter six pertains to feedback loops for reduction of error, static and astatic errors and systems, periodic and aperiodic error, and combined feedback control links. There is an extensive development of the mathematical foundation of control circuits. Chapter seven deals with the same phenomena when they are applied to nonlinear systems; relay control systems, stability through harmonic linearization, inherent nonlinearity, and logic devices applied to feedback. The mathematical treatment is quite rigorous. Chapter eight is a verbal discription of optimal, self-tuning, and self-organizing systems within the context of chapters six and seven. There is little mathematical treatment of the subject matter. TAB

N68-27152# California Univ., Berkeley. Electronics Research Lab.
ELECTROMAGNETIC WAVE CHANGE INTERACTION IN CROSSED FIELDS Quarterly Progress Report, 16 Aug.-15 Nov. 1967
K. A. Fox, M. A. Meyer, S. Swierkowski, C. W. Turner, T. Van Duzer et al Mar. 1968 57 p refs
(Contract DAAB07-67-C-0227)
(ECOM-0227-2; QPR-2; AD-668690)

The construction of a crossed-field amplifier which will incorporate the results of our noise studies is in progress. Efforts have recently been concentrated on the measurement of the omega-beta relation of a flattened-helix circuit. The paraxial crossed-field gun design method developed by R. A. Rao is being carried on to obtain designs for magnetically shielded guns. It has been found that in the case of a nonuniform magnetic field the paraxial ray equation as presented by R. A. Rao must be modified to include a term involving the first derivative of B with respect to distance normal to the beam trajectory. The possibility of obtaining photo emission from the cathode of a crossed-field microwave vacuum tube is studied. Photocurrents of 240 mA have been obtained using a SbCs coated photocathode with a 2.1 watt light beam focused to an area of 40 sq mm. An argon laser was used in the experiments. It appears that photoelectric emission, but not thermionic emission, can be stimulated in interesting amounts by sources having power levels of a few watts. An experimental and theoretical evaluation of the crossed-field acoustic-wave amplifier is being conducted. The useful frequency range is being determined for this device using InSb, the most suitable material available at present. Electromagnetic and space-charge waves in solid conductors are being studied in order to determine if there are microwave device applications. During this quarter an instability theorem was derived which states the necessary conditions for amplification in bulk conductors. It shows that transverse rf fields are necessary for amplification in an electron-hole plasma. Author (TAB)

N68-27199# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
STUDY OF TRANSVERSE WAVE INTERACTIONS Fifth Triannual Report, 1 Sep.-31 Dec. 1967
K. I. Talbot, C. H. Durney, and R. W. Grow Apr. 1968 24 p refs
(Contract DA-28-043-AMC-01279(E))
(UTEC-MD-68-011; ECOM-01279-9; Rept.-9; AD-668937)

The purpose of this project is to evaluate analytically and experimentally the interaction of waves in a wave guide with waves on a rotating electron beam. The methods of analysis include use of a general coupled-mode theory, a ballistic computer program, and an experimental evaluation. It has been found that the previous power saturation criteria are invalid because they were based on a one- and two-dimensional model. A possible criterion is presented based on a three-dimensional model. The power output of the tube is still low, but it is expected that magnetic field shaping will increase it. Also, the tube has been observed to oscillate in two different modes separated in frequency by about 50 MHz. Author (TAB)

N68-27207* Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
OPTIMIZATION OF STOCHASTIC CONTROL PROCESSES WITH RESPECT TO PROBABILITY ON ENTERING A TARGET MANIFOLD
J. Y. S. Luh and G. E. O'Connor, Jr. Oct. 1967 235 p refs
Prepared for JPL
(Contracts NAS7-100; JPL-950670)
(NASA-CR-95140; TR-EE67-15) CFSTI: $3.00 CSCL 09C

The problem of generating an open-loop control to drive a stochastically disturbed system from a given initial state to a target manifold is considered. The control is to be optimum with respect to a performance index which contains a probability term and an energy term. The probability term is the probability of entering the target manifold during some instant of a specified time interval. Two approaches to this problem are investigated. The first approach is to obtain a closed form approximation to the probability term by generating an approximate solution to a diffusion equation, and then applying Pontryagin's Maximum Principle. The second approach is to formulate an appealing one-parameter class of controls, and search this class over its parameter. In this approach, the probability term is found by observing a digital simulation of the system. Author

N68-27303# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SEMICONDUCTOR ELECTRONICS [POLUPROVODNIKOVAYA ELEKTRONIKA]
Ya. A. Fedotov *In its* Radio 70 Yr. 30 Jun. 1967 p 311-332
(See N68-27287 16-07)

The development of semiconductors and their impact on the acceleration of space technology is presented. Basic achievements in the production of semiconductors are reviewed, including photolithography, epitaxial plating, and microminiaturization are discussed briefly. Author

N68-27392# RAND Corp., Santa Monica, Calif.
FINDING OPTIMAL POLICIES IN DISCRETE DYNAMIC PROGRAMMING
Bruce L. Miller Apr. 1968 18 p refs
(Contract F44620-67-C-0045)
(RM-5601-PR; AD-668760)

The problem considered is the discrete time multichain decision problem introduced and largely solved by Howard (Dynamic Programming and Markov Processes, Technology Press and John Wiley + Sons, Inc., New York 1960). A policy iteration algorithm is developed that obtains an optimal stationary policy for the discount problem involving all discount factors sufficiently close to one. (These are the policies that Blackwell has termed optimal and has proved existed.) The algorithm is excellent for a decisionmaker who knows that he should use a low discount rate but doesn't know what it should be. Author (TAB)

N68-27402*# California Univ., Berkeley. Electronics Research Lab.

SECOND ORDER CONDITIONS OF OPTIMALITY FOR CONSTRAINED OPTIMIZATION PROBLEMS IN FINITE DIMENSIONAL SPACES

E. Polak and E. J. Masserli [1967] 5 p refs Presented at the Hawaii Intern. Conf. on System Sci., Honolulu, 29–31 Jan. 1967
(Grant NsG-354)
(NASA-CR-89909) CFSTI: HC$3.00/MF$0.65 CSCL 09C

The special case of linear dependence caused by the gradient $\nabla f(\hat{x})$ being zero is investigated. A new condition, involving second order partial derivatives of the equality constraint function r(·), and first order partial derivatives of the equality constraint function r(·), is obtained. This new condition holds for all perturbation vectors in the convex cone associated with the general (first order) necessary condition—a set which is larger than the one usually considered in obtaining second order conditions. Author

N68-27403*# General Precision, Inc., Little Falls, N. J.

A UNIFIED APPROACH TO SUBOPTIMUM CONTROL

Bernard Friedland and Philip E. Sarachik [1967] 17 p refs
(Contract NAS2-2648)
(NASA-CR-80383) CFSTI: HC$3.00/MF$0.65 CSCL 09C

A class of suboptimum control techniques is developed on the basis of the linear relation $\psi = M\xi$ between a change ψ in the adjoint vector p to a change ξ in the state x in the vicinity of the optimum trajectory. The matrix M relating ψ to ξ can be obtained by solving a linear two-point boundary-value problem or from the matrix Riccati equation. One application of this technique uses the solution of a simplified problem as the nominal trajectory; a second application is based on a precomputed nominal trajectory, and a third makes use of the relationship $p = Mx$. Instantaneous constraints on the control variable are permissible with these methods, although formal treatment of impulse terms may be required. Two examples show the performance of the techniques. Author

N68-27627 Duke Univ., Durham, N. C.

THE NONLINEAR THEORY OF SOME TRANSITOR AND TUNNEL DIODE OSCILLATORS

Donald Larry Hester (Ph.D. Thesis) 1967 135 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-9747

A unified approach is used to develop the nonlinear theory of a number of simple transistor and tunnel diode oscillators. The approach is a voltage vs. flux phase plane analysis which results when the flux of the coupled inductors is used as the system variable. By using the Ebers and Moll large signal model for the transistor, simplified versions of tuned-collector, tuned-base, and Hartley transistor oscillators are shown to be characterized by a nonlinear differential equation. The existing nonlinear theory of tunnel diode oscillators is extended to include a push-pull configuration and a Marzolf inverter. In both cases a fourth-degree polynomial is used for the tunnel diode nonlinear resistance and the system equation reduced to the standard form of Rayleigh's equation. Dissert. Abstr.

N68-27673 State Univ. of New York at Buffalo.

OPTIMAL CONTROL OF A MULTIVARIABLE STOCHASTIC PROCESS AS APPLIED TO A HYDROFOIL BOAT

Sabi Joseph Asseo (Ph.D. Thesis) 1967 289 p
Available from Univ. Microfilms: HC $13.05/MF $3.75 Order No. 67-10116

The optimal control aspects of a multivariable stochastic process are investigated on the basis of the minimization of a nonquadratic performance index of a hydrofoil boat formulated in this dissertation. The equations of motion of the controlled and uncontrolled boat are derived and the simplifying assumptions made in the derivation of those equations are listed. The dynamics of a hydrofoil boat during hull slamming and foil broaching are investigated and the resulting accelerations are expressed in terms of the random variables in each process. An analytical solution for the probability density function of intervals between consecutive level crossings of ocean waves is presented. The probability density function is approximated by a simpler distribution function by which all the central moments of the random process are computed. Dissert. Abstr.

N68-27690 Duke Univ., Durham, N. C.

A STUDY OF SYSTEM FORMULATIONS USING TENSOR METHODS

Richard Gaylon Absher (Ph.D. Thesis) 1967 156 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-9738

This dissertation describes the development of formulations for lumped-parameter systems using tensor methods. The systems are represented in n-dimensional spaces having an invariant infinitesimal arc length with dimensions of energy or energy-time. The goedesic equations of these spaces correspond to the equations of system response. The formulation in energy space describes general conservative, simple non-linear, and simple source-sink systems. In energy space a vector energy is defined as a vector whose components are the element energies of the system. This concept leads to a choice of metric coefficients which result in a representative space which is Euclidean. When applied to a simple inductor-capacitor system, the geodesic equations in conjunction with either a statement of energy conservation or system interconnection constraints are shown to properly describe the system. Dissert. Abstr.

N68-27714 State Univ. of Iowa, Iowa City.

PARAMETER SENSITIVITY OF LINEAR TIME-INVARIANT, DYNAMIC SYSTEMS

Devendar Chinchode Reddy (Ph.D. Thesis) 1967 96 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-9094

Several possible sets of sensitivity functions are defined both in the frequency domain and state space representation of the system. These functions relate "small" changes in system parameters, that inevitably occur in the assembly or the operation of a plant, to the characteristic roots of the system or some measures of system performance. The linear or approximately linear dynamical system is specially the object of our investigation. A new approach for the analysis of system behavior when subjected to parameter variations is indicated. The necessary and sufficient conditions for a totally parameter invariant response in the presence of small but arbitrary parameter changes are derived. Finally, the new approach of analysis is applied to a practical problem of interest, and a possible synthesis procedure is indicated for the reduction of sensitivity to parameter changes. Dissert. Abstr.

N68-27751# Douglas Aircraft Co., Santa Monica, Calif. Missile and Space Systems Div.

SELF ORGANIZING CONTROL SYSTEMS. VOLUME 7: METHODOLOGY AND GENERAL PURPOSE FORTRAN 4

PROGRAMS FOR THE SYNTHESIS AND UTILIZATION OF MULTIVARIABLE POLYNOMIAL DISCRIMINANT FUNCTIONS
J. M. Mendel and W. E. Byrne Apr. 1968 156 p refs
(DAC-62203)

CONTENTS:

1. METHODOLOGY FOR THE SYNTHESIS AND UTILIZATION OF MULTIVARIABLE POLYNOMIAL DISCRIMINANT FUNCTIONS, PART 1 p 1–67 (See N68-27752 16-10)

2. GENERAL PURPOSE FORTRAN IV PROGRAMS FOR THE SYNTHESIS AND UTILIZATION OF MULTIVARIABLE POLYNOMIAL DISCRIMINANT FUNCTIONS, PART 2 p 69–149 refs (See N68-27753 16-10)

N68-27752# Douglas Aircraft Co., Santa Monica, Calif. Missile and Space Systems Div.
METHODOLOGY FOR THE SYNTHESIS AND UTILIZATION OF MULTIVARIABLE POLYNOMIAL DISCRIMINANT FUNCTIONS, PART 1
In its Self Organizing Control Systems. Vol. 7: Methodology and General Purpose Fortran 4 Programs for the Syn. and Util. of Multivariable Polynomial Discriminant Functions Apr. 1968 p 1–67 (See N68-27751 16-10)

Methodology the synthesis and utilization of multivariable polynomial discriminant functions is detailed; and attention is given to quasi-optimal control, the method of trainable controllers, quantum-encoding and polynomial feature processing, and synthesis of discriminant functions for the time-optimal control problem. The application of training algorithms is investigated for the problem of designing multilevel, quasi-optimal controllers for dynamic processes. Consideration is given to the structure of a trainable controller, training in the context of the multilevel control application, a collection of subproblems that must be solved when pattern recognition techniques are used to synthesize multilevel controllers, and the use of the techniques for function approximation, conditional probability approximation, and probability density approximation. M.W.R.

N68-27753# Douglas Aircraft Co., Santa Monica, Calif. Missile and Space Systems Div.
GENERAL PURPOSE FORTRAN 4 PROGRAMS FOR THE SYNTHESIS AND UTILIZATION OF MULTIVARIABLE POLYNOMIAL DISCRIMINANT FUNCTIONS, PART 2
In its Self Organizing Control Systems. Vol. 7: Methodology and General Purpose Fortran 4 Programs for the Syn. and Util. of Multivariable Polynomial Discriminant Functions Apr. 1968 p 69–149 refs (See N68-27753 16-10)

Five Fortran IV programs are presented for the synthesis of multivariable polynomial discriminant functions. The first program generates sets of signatures. The second program uses the signatures to evaluate single variable orthonormal polynomials for each element of a set of pattern vectors and evaluates multivariable orthonormal polynomials for the set of pattern vectors. The third program uses a set of pattern vectors and their associated categories to synthesize a discriminant function where multivariable polynomials (nonorthonormal), when needed in the training process, are evaluated from the pattern vector elements. The fourth program uses the set of single variable orthonormal polynomials evaluated in the second program and the signatures generated in the first program to synthesize a discriminant function where multivariable polynomials, when needed in the training process, are evaluated from the single variable polynomials. The fifth program uses the set of multivariable orthornormal polynomials evaluated in the second program to synthesize a discriminant function. Author

N68-27799 Washington Univ., St. Louis, Mo.
OPTIMAL ADAPTIVE CONTROL OF LINEAR DISCRETE SYSTEMS
William John Murphy (D.Sc. Thesis) 1967 94 p
Available to Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-9390

The optimal, adaptive control of linear, discrete, stochastic systems with scalar input and output are studied. The dynamics of the system to be controlled are known only to the extent that the pertinent system parameters are specified by a set of Gaussian, a priori statistics. Due to the uncertainty of the plant dynamics and the stochastic nature of the system, the performance criterion considered is that of minimizing the expected value of an additive cost functional conditioned upon the information available at the time of control application. It is shown that, for this type of performance criterion, the selection of the optimal control sequence can be made by considering a set of sufficient statistics on the unknown variables in lieu of the entire collection in input and output data. Dissert. Abstr.

N68-27800# Illinois Univ., Urbana. Biological Computer Lab.
AN AUTOMATIC STOCHASTIC PREDICTOR
Russell D. Stinaff 7 Nov. 1967 29 p
(Contract AF 33(615)-3890; Grant AF-AFOSR-7-67)
(BCL-8-2; AFOSR-68-0773; AD-668555)

The document describes an electronic implementation of W. R. Ashby's theory of 'prediction' in state-determined systems with stochastic forcing operators. The automatic stochastic prediction theory is discussed, and possible biological applications are indicated. The machine is a simulation model adequate to demonstrate the achievement of equilibrium under the simple composite operator (sigma sub A, alpha, rho). Author (TAB)

N68-27816 Purdue Univ., Lafayette, Ind.
ON THE FINITE STOPPING RULES AND NONPARAMETRIC TECHNIQUES IN A FEATURE-ORDERED SEQUENTIAL RECOGNITION SYSTEM
Yi-tzuu Chien (Ph.D. Thesis) 1967 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-10178

A class of sequential recognition problems in which the number of feature measurements required to assign class membership to each pattern sample depends on the outcome of the previous measurements is considered. The sequential recognition structure allows the categorizer to observe the feature measurements one at a time, and each time the decision of the categorizer consists of both the choice of closing the sequence of observations and making a terminal decision (namely, assigning class membership to a pattern sample) and the choice of taking another measurement before coming to a terminal decision. The procedure essentially decomposes the single-state decision process into a multistage decision process, governed by a finite stopping rule which requests no more than the total number of feature measurements available. Dissert. Abstr.

N68-27841 Purdue Univ., Lafayette, Ind.
THRESHOLD STUDY OF PHASE LOCK LOOP SYSTEMS
John Joseph Uhran, Jr. (Ph.D. Thesis) 1967 170 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-10267

This research has been concerned with the study of two aspects of phase lock loop systems. The first is the effect that the phase comparator, a non-linear device operating on the phase difference between reference and signal has an overall performance. The second directly related to the first, is the study and defining of the threshold phenomena. Several comparators were chosen ad-hoc and analyzed using a Fokker–Planck model. Because the model is only approximate in the threshold region a carefully designed experimental evaluation of a first and second order sine, tanlock and tanlock squared comparator was undertaken. It is shown that the additional complexity involved in using other comparators rather than the relatively simple sine comparators can be justified particularly when additional tracking range is required. For second order systems, it is shown that critical damping provides optimum performance in terms of tracking and threshold. Dissert. Abstr.

N68-27896 California Univ., Los Angeles.
ENTROPY ANALYSIS OF FEEDBACK CONTROL SYSTEMS
Henry Lawrence Weidemann (Ph.D. Thesis) 1967 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-9900

This dissertation is a study of the application of the entropy function of information theory to the analysis of sampled data systems. Studied are both feed-forward and feedback with the emphasis placed on the regulator problem. The feature common to all the configurations is the presence of a sensor which measures the input signal and which has an output that is usually some random function of the input. For the purposes of the analysis it is conveneient to describe the behavior of the sensor by its sensor channel transmittance, which is defined as the mutual information between the input and output of the measuring device. For the proofs relating to the estimation problem the constraints on the system elements are so relaxed that the sensor model need not be known and the only description of this device that is required is its sensor channel transmittance. For the feedback problem the restrictions are somewhat tighter in that although the sensor data processing may be nonlinear the noise must be constrained to be additive. However this class of sensors is very important and the theory of feedback control is advanced significantly. Dissert. Abstr.

N68-28056*# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Electrical Engineering.
PROGRAM IN ELECTRO-PHYSICAL STUDIES: MICRO-CIRCUIT MODELS AND DIAGNOSTIC TECHNIQUES FOR ENVIRONMENTAL FAILURE MODE PREDICTION
G. J. Herskowitz, T. J. Kobylarz, and E. Zaheb May 1968 98 p refs
(Grant NGR-31-003-050)
(NASA-CR-95354; EP-1) CFSTI: HC$3.00/MF$0.65 CSCL 09A

Modeling procedures and analytical techniques were developed for predicting microcircuit failure modes under adverse environmental conditions. A systematic procedure, based upon the Linvill lumped-parameter representation, was used in deriving microcircuit models directly from structure, material properties, and known radiation and thermal effects. The NASAP computer program, based upon flow graph techniques, was used to analyze the response of a linear microcircuit under the effects of radiation. Diagnostic techniques, based upon the statistical tolerance calculated from sensitivity functions, were developed and applied to the formulation of design procedures for microcircuits which are insensitive to adverse environmental effects. As one of the major problems encountered was that of nonlinear effects occurring because of large environmental disturbances, a nonlinear capability was developed for the NASAP. Algorithms for sensitivity and worst-case analyses of nonlinear networks are presented as a basis for developing diagnostic techniques for microcircuits operated in a nonlinear mode. Application of the nonlinear program to nonlinear Linvill lumped-parameter models of semiconductor devices is demonstrated. Author

N68-28307*# General Precision, Inc., Little Falls, N. J.
ADDITIONAL STUDIES OF QUASI-OPTIMUM FEEDBACK CONTROL TECHNIQUES
Bernard Friedland, Frederick E. Thau, Sanford Welt, Chong K. Ling, and Michael Schilder Washington NASA Jul. 1968 144 p refs
(Contract NAS2-3636)
(NASA-CR-1099) CFSTI: HC$3.00/MF$0.65 CSCL 09A

A quasi-optimal control technique was investigated by approximating a complicated dynamic process by a simpler process, designing a control system for the latter, and amending the design to account for any difference between the original process and the approximation. The simplified process must be a reasonably faithful representation of the original process and the solution of the two-point boundary-value problem governing the optimal control law of the process must be reducible to manageable proportions. The correction to the optimal control law requires evaluation of a correction matrix with a matrix Riccati equation, whose solution matrix is then used to correct the solution to the simplified process. Theoretical studies on the performance of the quasi-optimal control law as well as stochastic optimum control are reported. Applications are included for the three-axis attitude control of a space vehicle; minimum-time, bounded acceleration rendezvous in a central force field; and an aircraft landing problem. Some aspects of the inverse optimal control problem are considered for a class of nonlinear autonomous systems. M.W.R.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N68-27021# Los Alamos Scientific Lab., N. Mex.
MEDIUM-ENERGY PHYSICS PROGRAM Quarterly Status Report, Period Ending 31 Jan. 1968
29 Feb. 1968 36 p refs
(Contract W-7405-ENG-36)
(LA-3884-MS) CFSTI: HC$3.00/MF$0.65

Development of the 20-MeV electron prototype linear accelerator is discussed. Topics include rf power sources, control, instrumentation, experimental facilities, and accelerator physics. Also, LAMPF scheduling and facility construction are outlined. NSA

N68-27032# Stanford Univ., Calif. Linear Accelerator Center.
TWO-MILE ACCELERATOR PROJECT Quarterly Status Report, 1 Jan.–30 Jun. 1967
Jan. 1968 124 p refs
(Contracts AT(04-3)-400; AT(04-3)-515)
(SLAC-80) CFSTI: HC$3.00/MF$0.65

A status report on the Stanford Linear Accelerator Project covering the period January 1, 1967 to July 1, 1967 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. NSA

N68-27141 Michigan State Univ., East Lansing.
PRECISE METHODS FOR PRE-CALCULATION OF CYCLOTRON CONTROL SETTINGS
Richard Eugene Berg (Ph.D. Thesis) 1966 135 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-7521

A computer program, SETOP, has been written which uses measured magnetic fields and a pre-computed set of ideal averate fields to determine "operating points" for the MSU variable-energy, multi-particle cyclotron; to obtain a complete set of operating instructions, the experimenter need only specify the particle and energy of interest. Control settings are computed in a straightforward sequence of operations: (1) the fields at the desired excitation are synthesized by interpolation in the measured field data, (2) an average field is obtained using a modified least squares fit of the desired average field by the trim coils, and (3) the RF frequency is determined so as to minimize the energy spread of the beam in a single turn at the extraction energy. Dissert. Abstr.

N68-27419*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

VTOL CONTROL SYSTEM STUDIES ON A SIX-DEGREE-OF-FREEDOM MOTION SIMULATOR

Richard K. Greif, Emmett B. Fry, Ronald M. Gerdes, and Terrence D. Gossett [1966] 39 p refs Presented at the Intern. Council of the Aeron. Sci., London, 11–16 Sep. 1966
(NASA-TM-X-59065) CFSTI: HC$3.00/MF$0.65 CSCL 14B

VTOL control concepts, with and without stabilization, were optimized and compared on a six-degree-of-freedom motion simulator. Features of this simulator and its suitability for VTOL research are discussed. Results are presented to show which control concepts provide the best handling qualities and require the least control power, both in calm air and in the presence of random disturbances. The discussion includes a brief treatment of nonlinear concepts and system failure effects. Author

N68-27433*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DISCUSSION OF THREE TYPICAL LANGLEY RESEARCH CENTER SIMULATION PROGRAMS

Ellis J. White [1966] 35 p Presented at the Eastern Simulation Council, Princeton, N. J., 20 Oct. 1966
(NASA-TM-X-59116) CFSTI: HC$3.00/MF$0.65 CSCL 14B

This discussion deals with three typical simulation programs at Langley in the areas of aerodynamic flight, lunar flight, and near-earth space flight. The simulation requirements in terms of the mission, the vehicle, and the simulation hardware are discussed for each problem. The mathematical models are mentioned in general and particular emphasis is given to the computer considerations of each in terms of the layout and the size and types of computers utilized. The computational considerations such as integration schemes, sampling rates, and central processing unit time of an all-digital approach to an earth orbit rendezvous problem is presented and the results compared to a hybrid approach. Capabilities of Langley's future digital simulation complex are discussed. Author

N68-27544*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SST OPERATIONS: TERMINAL AREA PROBLEMS

Richard H. Sawyer [1967] 12 p refs Presented at the RTCA Ann. Assembly Meeting, Washington, D. C., Sep. 1966
(NASA-TM-X-59047) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Based on a joint NASA–FAA research program, vertical flight path control problems regarding supersonic transport (SST) operations in the terminal area are identified and described. As the SST during climbout will be required to operate as closely as possible to maximum allowable operating speed and sonic boom overpressure limitation boundaries, the problems are foreseen as (1) a high degree of susceptibility to overspeeding at subsonic speeds because of the high acceleration-climb capability in this regime; (2) the difficulty of following the sonic boom overpressure limitation at supersonic speeds, as there is no constant flight parameter along this boundary; and (3) the difficulty of transition from climbing flight into cruise flight without overshooting or undershooting altitude and/or speed. Also considered are descent procedures for the SST, and the need for developing a pitch attitude display of increased sensitivity (of the order of 5:1) for use at supersonic speeds. M.G.J.

N68-27558# New Mexico Univ., Albuquerque. Bureau of Engineering Research.

THE DYNAMIC LOW CYCLE TESTING MACHINE (DESIGN AND CALIBRATION)

Michael J. Shannon Dec. 1967 68 p refs
(Grant AF-AFOSR-568-66)
(ME-31; AFOSR-68-0267; AD-669132)

The design and development of a loading device for subjecting a reversed shear specimen to a pulsed dynamic load is described. The development includes a calibration technique to confirm that design criteria were met. A relationship between plastic deformation and peak tensile load is presented. Author (TAB)

N68-27658*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A REVIEW OF FACILITIES AND TEST TECHNIQUES USED IN LOW-SPEED FLIGHT

Seth B. Anderson and Laurel G. Schroers [1967] 34 p refs Presented at the Intern. Congr. of Subsonic Aeron., New York, 3–6 Apr. 1967
(NASA-TM-X-60088) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Facilities and test techniques developed for studying low-speed problems of handling qualities, stability and control, and performance are described. Flight test facilities covered included: (1) multi-motion piloted ground based simulators; (2) ground test rigs for checking the functioning of the entire aircraft in a partial flight environment; (3) airborne test rigs to assist in the development of complex VTOL aircraft; and (4) variable-stability aircraft to help define the effects of aircraft size including the aerodynamic parameters peculiar to large aircraft and the effect of pilot position. Flight test techniques considered were measuring hover control power for VTOL aircraft; measuring the ground effect on delta winged aircraft; stalling behavior of new aircraft designs; and recirculation and ingestion problems. The relative merits and limitations of each facility and technique are pointed out, and future needs are discussed. A.L.

N68-27692*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A HIGH ENTHALPY PLASMA GENERATOR FOR ENTRY HEATING SIMULATION

Charles E. Shepard, Donald M. Ketner, and John W. Vorreiter [1967] 9 p refs Presented at the 1967 Ann. Meeting of the Inst. of Environ. Sci., Washington, D. C. 10–12 Apr. 1967
(NASA-TM-X-59856) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The NASA-developed Constricted-Arc Supersonic Jet, capable of center-line enthalpies in excess of 3×10^8 joules/kg (130,000 Btu/lb), has a variety of applications, the most important probably being the simulation of entry heating from interplanetary missions. Within this plasma generator, a supersonic nozzle with an elongated throat, or arc constrictor, a dc arc, and a longitudinal flow of gas are maintained. The working fluid, which may be air or any other gas, is heated as it passes near the arc, becomes electrically conductive, and eventually becomes a part of the arc core. The core temperature is maintained by current flow while the gas passes through the supersonic nozzle into the test section. Several configurations of this apparatus were built and tested; the largest operates at a power input of 5 MW with an efficiency of about 50%. Total enthalpies and impact pressures corresponding to flight at 10 km/s at 60 km altitude and 30 km/s at 100 km altitude can be achieved. Major performance limitations are the maximum wall heat flux that can be removed by the cooling water, the maximum current that can be maintained without electrode erosion and subsequent stream contamination, and the maximum voltage gradient that can be maintained without destructive arc-over. Author

N68-27694*# General Technical Services, Inc., Upper Darby, Pa.
ACTIVE PRIMATE SIMULATOR Final Report
A. S. Iberall, Carl Beckman, D. Lulejian, F. Pavone, and E. Pikalow
15 May 1968 122 p refs
(Contract NASw-1638)
(NASA-CR-95217) CFSTI: HC$3.00/MF$0.65 CSCL 06B

Systems engineering data and design specifications are presented on the active primate simulator which was developed to simulate the small primate to be used in the 30-day Biosatellite flight. Its purpose was to simulate a number of primate physiological parameters and to stimulate the signal conditioners interfacing with the primate in the space capsule. Significant design problems are described, along with the technical approach used in their solution. Block diagrams and wiring schematics illustrate the test. The associated test system is also described, and extensive test data are included. M.G.J.

N68-27713# Weapons Research Establishment, Salisbury (Australia). Dept. of Supply.
WEAPONS RESEARCH ESTABLISHMENT Annual Report, 1966–1967
1967 58 p
CFSTI: HC$3.00/MF$0.65

Project activities, research activities, and equipment and technique developments at the Weapons Research Establishment in South Australia are reviewed. Projects include reentry physics research under the Sparta Project, European Launcher Development Organization (ELDO) activities, weapons trials at Woomera, and Ikara sonar equipment; along with activities in connection with NASA tracking, the Smithsonian Astrophysical Observatory, and the Johns Hopkins Applied Physics Laboratory navigational and geodetic satellites. Research activities are summarized under the headings of flight dynamics, rocket propulsion, upper atmosphere studies, weapons evaluation, and lasers. Among the equipment and techniques are thin film optics, closed circuit television, gas scrubbers for toxic gases, and a gaseous oxygen generator. Others are electronics and vibration and temperature testing of electronic equipment, gear boxes for instrumentation systems, crystal growing, and digitalized voide communications. M.W.R.

N68-27872*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
USING SIMULATION FOR RESEARCH AND USING RESEARCH TO DEVELOP VALID SIMULATION TECHNIQUES
Roy F. Brissenden [1967] 43 p refs Presented at the SAE 3d Intern. Simulation and Training Conf., New York, 24–27 Apr. 1967
(NASA-TM-X-59801) CFSTI: HC$3.00/MF$0.65 CSCL 14B

This paper outlines the major factors involved in designing simulators that have "practical" fidelity without being overdesigned. A closed-loop logic for the development and use of simulation is set forth. The simulation approach is developed around three basic design categories—the basic computer and servomechanism technology, the human engineering criteria, and control information. The control-information category is discussed extensively, and respresentative fixed- and moving-base research simulators in use at the Langley Research Center are presented to describe specific display designs and motion-cue effects. Author

N68-27948# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.
NEW RAPID SITE CONSTRUCTION TECHNIQUES FOR SUPPORT FACILITIES
A. Vasiloff *In its* Expandable and Modular Struct. Conf. May 1967 p 641–663 refs (See N68-27917 16-32)

The development of new methods to quickly, within hours, fabricate a rigid, load bearing surface that can be utilized with a particular shelter mission is reported. Examined are three areas of research which focus on the development of (1) a fast curing plastic resin which can be sprayed on the ground surface to fabricate a load bearing surface; (2) sprayed molten sulphur techniques (with fiberglass reinforcing agents) for fabricating load bearing surfaces; and (3) ultra-fast cure cements to rapidly repair bomb damaged runways. Based on results obtained from research test programs in these three areas it is concluded that: (1) the fabrication of load bearing sites for shelter and hangar floors by the plastic/fiber glass application method is feasible; (2) the use of molten sulphur as a rapid preparation material has application for certain missions, and further research is needed to extend its usefulness; and (3) the use of a new ultra-fast cure cement, pumped at a high rate, appears to hold promise for rapid fabrication of load bearing surfaces that will equal standard concrete performance. S.C.W.

N68-27990# Wyle Labs., Inc., El Segundo, Calif.
VIBROACOUSTIC ENVIRONMENTAL SIMULATION FOR AEROSPACE VEHICLES
Kenneth McK. Eldred *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 1–11 refs (See N68-27989 16-32)

Requirements for vibroacoustic simulation in the laboratory in support of vehicle reliability goals are discussed. The qualitative nature of the vibration environment for a typical space payload mission is discussed, and the concept of the vibration field within the vehicle as a description of the vibration environment for both flight and simulation is developed. Problems in conventional laboratory vibration testing, the notion of structural sufficiency, and comments on the possible requirement for combined load testing are presented. The simulation potential of the new vibroacoustic test facilities is related to these simulation requirements. Author

N68-27991# Wyle Labs., Inc., Huntsville, Ala.
OPERATIONAL CHARACTERISTICS OF A 100,000 CUBIC FOOT ACOUSTIC REVERBERATION CHAMBER
Fancher M. Murray *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 13–24 refs (See N68-27989 16-32)

Use of a 100,000-cu-ft reverberation room has resulted in a significant mass of data relating to large reverberation rooms in general. Overall sound pressure levels of 152–154 db may be generated away from the walls, while the classic 6-db and 9-db increases are seen at the walls and in the corners, respectively. Tests performed with large specimens show that good spectral and spatial sound distribution may be generated and controlled. The room exhibits a reverberation time of 18 sec at frequencies below 200–300 Hz, while classic air absorption controls damping above this range. The room is driven by one, two, or four airstream modulators of the vibrating vane type. Instrumentation available in the room includes direct cable connection to 160 channels of charge amplifiers in a central instrumentation complex. Switching capability allows acquisition of a total of 480 data channels. The charge amplifiers are connected to multiplexers and an A–D converter for on-line data acquisition by a high-speed digital computer. Computer programs were developed to accept these data, store it, and then produce final plots of power spectral density, auto- and cross-correlation, amplitude distribution, and other pertinent parameters related to the acoustic driving forces and the specimen responses. Theoretical and experimental data will be presented to show the operational characteristics of this large reverberation chamber. Author

N68-27992*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

CONCEPT, DESIGN, AND PERFORMANCE OF THE SPACECRAFT ACOUSTIC LABORATORY

Robert J. Wren, Wade D. Dorland, James D. Johnston, Jr., and Kenneth McK. Eldred (Wyle Labs., Inc., El Segundo, Calif.) *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 25–54 refs (See N68-27989 16-32) CSCL 14B

To obtain the best possible ground test verification of the flightworthiness of the Apollo spacecraft to launch and boost fluctuating pressure environments, the NASA Manned Spacecraft Center conceived, designed, and constructed the Spacecraft Acoustic Laboratory which embodies a unique vibratory simulation technique and capability. Apollo acoustic levels and spectra were used to develop acoustic test energy requirements and frequency considerations in the design of the sources, horns, and ducts. The test configuration includes 16 horn/duct channels, each driven by an independently controllable acoustic noise source, which completely envelop the vehicle and control the propagation of high-energy acoustic waves downward over the vehicle. Evaluation of the performance characteristics of the facility was oriented toward verification of acoustic test hardware design and, more importantly, toward comparison of Apollo vehicle vibration responses achieved in the ground test vs flight measurements. With minor exceptions (which were corrected), all acoustic parameters designed into the hardware have been met or exceeded. The shell response of the service module as measured at eight locations on an Apollo flight has been duplicated satisfactorily in the laboratory. Author

N68-27993# Wyle Labs., Inc., Huntsville, Ala.

THEORETICAL STUDY OF ACOUSTIC SIMULATION OF IN-FLIGHT ENVIRONMENTS

R. W. White *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 55–75 refs (See N68-27989 16-32)

Progressive wave and reverberant acoustic tests are often used for qualification of aerospace structures subjected to unsteady aerodynamic environments. Acoustic simulation of these in-flight environments is achieved if the structural vibration response to the acoustic excitation is equivalent, over the frequency range of interest, to that which occurs during flight. To determine the degree of response simulation that could be expected for such testing of the Apollo vehicle, responses of the spacecraft lunar module adapter were estimated for a modified progressive wave field, a reverberant acoustic field, and for boundary-layer turbulence. Using an equivalent, uniform, pinned-end cylindrical shell, space-average power spectral densities of acceleration were computed from 10 to 1000 Hz. The classic modal analysis method employing 570 independent degrees of freedom was used in the computations. The pressure fields were assumed to be homogeneous with rectangular space correlation patterns, and to have uniform power spectra over the shell. Theoretical and experimental results are compared; these indicate that approximate simulation is possible over a broad frequency range. Author

N68-28012# Atomic Energy Commission Research Establishment, Lucas Heights (Australia).

A SELECTIVE SURVEY OF LITERATURE ON WATER TUNNELS TO PROVIDE A BASIS FOR THE DESIGN OF THE LUCAS HEIGHTS WATER TUNNEL

D. B. Gleed and G. Saiva Oct. 1967 28 p refs
(AAEC/TM-410)

All types of water tunnels are discussed but particular emphasis is placed on the closed loop, closed jet tunnel design since this type gives maximum experimental flexibility. Individual tunnel components and ancillary equipment are discussed in detail. The bibliography gives references relating to tunnel design, performance and operation. Author (NSA)

N68-28046# United Kingdom Atomic Energy Authority, Culham (England).

EFFECT OF TOROIDICITY ON STELLARATOR MAGNETIC SURFACES

I. S. Danikin and I. K. Karpenko Dec. 1968 25 p refs Transl. into ENGLISH from Lebedev Univ., Preprint 114, Moscow, Aug. 1967 p 1–20
(NP-TR-1636; CTO-463) CFSTI: HC$3.00/MF$0.65

The magnetic surfaces of a stellarator with l = 2 are investigated in detail, taking into account the first correction for the curvature "K" of the system. In contrast to earlier papers, the expansion is extended over a wider region surrounding the magnetic axis the position of which, dependent on the current distribution in the helical stellarator windings, is determined by an exact solution for the potential of the magnetic field obtained earlier by Kovrizhnikh. This makes it possible to describe more precisely the system of magnetic surfaces in the region surrounding the axis and to consider the qualitative variation of their topology in the peripheral region (in the neighborhood of the separatrix of the initial system with K = 0). Author (NSA)

N68-28070# Cambridge Electron Accelerator, Mass.

[ON ELECTRON ACCELERATORS] Semiannual Report, 1 Jul.–31 Dec. 1967

4 Mar. 1968 47 p refs
(Contract AT(30-1)-2076)
(CEAL-1039) CFSTI: HC$3.00/MF$0.65

The operation of the 6-GeV Cambridge Electron Accelerator is described. Changes in the administrative organization of the laboratory are also reported. The general natures of the 30 experiments that were in progress or in preparation are summarized. The principal improvements made in the accelerator and in the associated facilities are listed. The progress made on Project Bypass is summarized, and it is shown that long-term storage up to 30 minutes at 3 GeV and multi-cycle injection affording a buildup factor exceeding 100 were accomplished successfully. Safety is discussed, and it is seen that there were no lost-time accidents and no excessive radiation doses. Author (NSA)

N68-28083# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.

A MAGNETIC FIELD FIT TO THE 30" BNL BUBBLE CHAMBER

Jay Maynard (Princeton Univ.), Uriel Nauenberg (Princeton Univ.), David Berley, Dean Campbell, Abraham Kasden et al 18 Jan. 1968 37 p Sponsored by AEC *Its* EP & S Div. Internal Rept.-68-1
(BNL-12374) CFSTI: HC$3.00/MF$0.65

The magnetic field of the BNL 30-inch hydrogen bubble chamber was measured on a 1 inch cubic lattice over the entire volume of the chamber. Three orthogonal components of the magnetic field were measured with three precisely oriented and calibrated Hall probes. A formula which describes the measurements to an accuracy of 0.2% and which satisfies Maxwell's equations exactly was derived. The coefficients of the field formula were adjusted with a program which utilizes the method of least squares. Author (NSA)

N68-28156# Royal Aircraft Establishment, Farnborough (England).

AN INFLATED MOBILE LIFTING SYSTEM FOR AN 8 TON LOAD

I. S. H. Brown and F. T. Kiernan Aug. 1967 20 p refs
(RAE-TR-67190) CFSTI: HC$3.00/MF$0.65

A system comprising an inflatable load-lifting canopy of oval planform with buoyancy tube and separate trailer for inflation and towing over water has been proved feasible for loads of up to 8 tons over smooth ground and calm water. Limits of performance in more severe conditions have not been determined.

For future applications and in particular for loads of various sizes and load distribution, a circular planform canopy should be considered, together with alternative methods of slinging, inflation, and propulsion. When used over porous surfaces and uneven ground, a blower with increased airflow would be of advantage to maintain air pressure and reduce friction and abrasion of the base of the structure. Author

N68-28159# Aeronautical Research Labs., Melbourne (Australia).

THE DESIGN OF A LOW-FREQUENCY MECHANICAL VIBRATOR

G. Long Aug. 1966 39 p refs
(ARL/SM-310) CFSTI: HC$3.00/MF$0.65

A mechanical vibrator capable of producing large sinusoidal forces at low frequencies is described. The machine is based on a system of force amplification through a tuneable mechanical resonance, the primary exciting force being applied by rotating out-of-balance weights. It is shown that for a given force output the primary force may be less than one thirtieth of that required in conventional mechanical vibrators. Frequency control is thereby improved and cyclic speed fluctuations are reduced. A vibrator of this type has been used successfully to excite the lower order modes of vibration of a 1500 ton motorship. Author

N68-28201# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).

THEORETICAL INVESTIGATION OF HALL TYPE PLASMA ACCELERATORS [THEORETISCHE UNTERSUCHUNG ELEKTROMAGNETISCHER PLASMABESCHLEUNIGER VOM HALL-TYP]

H. J. Junge and W. Oldekop Dec. 1967 46 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-84) CFSTI: HC$3.00/MF$0.65

A theoretical investigation of the important electric, magnetic, plasmadynamic and geometric influence on the characteristic properties of the idealized Hall–current plasma accelerator is given. Neglecting gradients of pressure and Hall-parameter the axial distribution of current density, plasma velocity, Lorentz-force density and efficiency was computed in dimensionless form. From plotting the computed values the result was found that for optimal conditions the electric and magnetic fields should be orthogonal and the Hall-parameter should be of the order of 100. Further for practical dimensions of the accelerator length strong magnetic fields are necessary. Author

N68-28217 European Organization for Nuclear Research, Geneva (Switzerland).

THE CERN ELECTRON STORAGE AND ACCUMULATION RING (CESAR)

6 Mar. 1968 182 p refs
(CERN-68-8)

This paper summarises the historical background, and gives a general description of the device, and the purposes for which it was used. Subsequent parts describe the design, construction and performance of the different components and the experimental results. The paper concludes with an evaluation of what was done with CESAR, in terms of original purposes for which it was built and of its possible further exploitation for purposes not originally foreseen. Author

N68-28225# Aeronautical Research Labs., Melbourne (Australia).

THE A.R.L. SUPERSONIC PROPULSION TEST TEST FACILITY—THERMODYNAMIC DESIGN OF REGENERATIVE HEAT EXCHANGER

A. Runacres and D. G. Stewart Mar. 1967 25 p refs
(ARL/ME-288) CFSTI: HC$3.00/MF$0.65

Investigations made in the course of the general thermodynamic design of the regenerative pebble bed heat exchanger for the A.R.L. Supersonic Propulsion Test Facility were presented. These have included consideration of the various air flow conditions to be met by the facility and the choice of pebble material, pebble size and bed dimensions. Restrictions imposed by the heater on operation of the facility are evaluated in a preliminary way and some mechanical aspects of the heater design are mentioned. Author

N68-28284# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Forschungsgruppe fuer Sondergebiete der Mess- und Regeltechnik.

SOME NOTES ON THE CENTRAL PROJECTION OF A GEODETIC GRID PATTERN ON A FIXED SCREEN IN THE AIRCRAFT WHICH IS PERFORMED ELECTRONICALLY FOR THE PURPOSE OF FLIGHT SIMULATION [UEBER DIE MIT ELEKTRISCHEN HILFSMITTELN BEWIRKTE ZENTRALPROJEKTION EINES ERDFESTEN QUADRATISCHEN RASTER AUF EINE FLUGZEUGFESTE SICHTSCHEIBE ZUM ZWECKE DER FLUGSIMULATION]

Rolf Fischer Dec. 1967 81 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-95) CFSTI: HC$3.00/MF$0.65

The student pilot using a simulator trainer requires obvious information as to the situation and the relative motion of the aircraft as indicated by the computer. For this purpose the earth is assumed to be a plane upon which is superimposed a square grid. The student pilot can see this grid on a screen in the same form as would be seen from an aircraft. It has been investigated as to how such a view can be generated electronically by analogue methods and displayed on an oscilloscope screen. Unfortunately it is possible to project only a section of the entire pattern accurately by electric voltages as the horizon cannot be included. Several approximations are propounded which allow for an accurate horizon. There are intermediate projections on a sphere or on a cylinder which may give an advantage to the problem. One method has been realized in an equipment and the results are enclosed. Author

N68-28311*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

CLEAN-ROOM FACILITIES FOR EXPLORER 35 SPACECRAFT

Francis N. Le Doux Washington Jun. 1968 16 p
(NASA-TN-D-4577) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Costly delays and failures in past spacecraft projects have been attributed to the inadequacy or lack of contamination control. Currently, NASA requires that automated spacecraft with mission in the near vicinity of the moon be biologically decontaminated to a level of no more than 2.59×10^6 viable spore forms at time of launch. To reduce particulate and biological contamination of Explorer XXXV, various classes of clean rooms were used. Debris generating operations were performed in uncontrolled areas with protection for flight hardware in the near vicinity. Decontamination, conformal coating, and encapsulation of electronics were performed in a class 10,000 conventional clean room; spacecraft buildup and some engineering tests were conducted in a class 100,000 conventional clean room. Electronic systems field checkout, cleaning and decontamination of small hand tools, instrument assembly, and/or functional operation tests, final spacecraft decontamination and assembly, and bioassaying were conducted in a class 100 bio-clean room environment. All clean room areas were restricted in number of personnel, clean-room dress, deportment, and procedures. On the basis of the biorecords, it was determined that the Explorer XXXV surfaces contained not more than 9×10^5 microorganisms before decontamination. This low level has been

attributed to the various clean-room environments and contamination controls utilized during assembly and/or testing.
Author

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N68-26964# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CALCULATION OF PLANE AND AXIALLY-SYMMETRICAL SUPERSONIC FLOWS IN THE PRESENCE OF IRREVERSIBLE PROCESSES

O. N. Katskova and A. N. Krayko 10 Aug. 1967 43 p refs Transl. into ENGLISH of the Publ. "Raschet Ploskikh i Osesimmetrichnykh Sverkhzvukovykh Techeniy Pri Nalichii Neobratimykh Protsessov" Moscow, Computational Center of Acad. of Sci. of the SSSR, 1964 p 1-44
(FTD-MT-67-70; AD-668232)

Contents: Equations of characteristics; Equations of characteristics in finite-difference form and scheme of calculation; Calculation of axially symmetric nozzles; Examples of calculation.
TAB

N68-27015# Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.

A COMPUTER PROGRAM TO SOLVE EDDY CURRENT PROBLEMS

J. Nelson Tunstall and C. V. Dodd 8 Apr. 1968 63 p refs
(Contract W-7405-ENG-26)
(K-1740)

The partial differential equation $\Delta A - A/r^2 = -\mu\iota + i\omega\mu\sigma A - \mu\{[\partial(1/\mu)/\partial r][(1/r)(\partial rA/\partial r)] + [\partial(1/\mu)/\partial z](\partial A/\partial z)\}$, where Δ is the differential operator $\Delta = \partial^2/\partial r^2 + [(1/r)(\partial/\partial r)] + \partial^2/\partial z^2$ and $A = A(z,r)$, with fixed boundary conditions is considered. A numerical technique of solution and a description of a computer code which uses this technique are presented. This equation arises from considering Maxwell's equations in a conductive, isotropic, inhomogeneous medium at low frequencies and assuming symmetry about the axis of the coil and a sinusoidal driving current.
Author (NSA)

N68-27024# Research Analysis Corp., McLean Va.

USER'S GUIDE TO A COMPUTER MODEL FOR PROJECTING THE IMPACT OF OFFICER PROCUREMENT, PROMOTION, AND RETENTION POLICIES

Leon W. Transeau Dec. 1967 168 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-286; AD-668905)

The document is a users guide to a computer model designed to project the impact that Army procurement, promotion, and retention policies will have on the future strength and composition of the commissioned officer forces. The model was designed for use by the Army to evaluate immediate operational policy alternatives and to assist in the formulation of long-range manpower policies.
Author (TAB)

N68-27036 Michigan Univ., Ann Arbor.

THE DYNAMICS OF MOVING BUBBLES IN SINGLE- AND BINARY-COMPONENT SYSTEMS

Naoyuki Tokuda (Ph.D. Thesis) 1966 135 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8353

The dynamics of a single bubble moving in a quiescent liquid is analyzed for single- and binary component systems. The analysis is made for the region in which the bubble dynamics is controlled by the transport of energy and/or mass subject to thermodynamic phase-equilibrium at the bubble interface. The dynamics of moving bubble in a single-component system is investigated initially. The interfacial temperature remains constant with time for this case. Two asymptotic solutions of the bubble dynamics for small and large times, are obtained by means of the coordinate perturbation method. The bubble behavior during small times is dominated by diffusion and/or radial convection while at large times it is controlled by diffusion and axial convection. The total heat flux over the entire bubble surface is evaluated and related to the interfacial energy balance condition. The resulting equation is integrated to yield the bubble growth or collapse rate. For binary component systems, both injection cooling and boiling are treated. Both the interfacial temperature and concentration vary with time.
Dissert. Abstr.

N68-27041 Michigan Univ., Ann Arbor.

ON THE STABILITY OF PARALLEL FLOWS OF VISCOELASTIC LIQUIDS

Dean Tritschler Mook (Ph.D. Thesis) 1966 66 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-8315

A general linear hereditary stress-strain law is used in studying the stability of plane parallel flows of viscoelastic liquids. In keeping with the usual procedure, a stability equation valid for liquids of arbitrary memory is derived by super-posing an infinitesimal, two-dimensional, periodic disturbance on the primary flow. It is shown that in the case of liquids with short memory this stability equation reduces to the one given by Walters in 1962. As asymptotic solution to the stability equation is obtained using the method of inner and outer expansions, as presented by Graebel in 1966. Corrections to his expansions are noted, and the results are compared to those obtained by Chan Man Fong and Walters in 1965. The results indicate that the elastic property of the liquid has a destabilizing effect on the flow.
Dissert. Abstr.

N68-27073# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

AEROSOL DEPOSITION FROM TURBULENT AIRSTREAMS IN VERTICAL CONDUITS

G. A. Sehmel 29 Mar. 1968 74 p refs
(Contract AT(45-1)-1830)
(BNWL-578) CFSTI: HC$3.00/MF$0.65

The general equations of continuity are set up to describe deposition of particles in which the eddy diffusivity is related to the Reynolds stress. Simplifying assumptions in the general equations as well as simplifying assumptions to obtain a workable model are discussed. The general equations are used as a basis from which to discuss existing models of turbulent deposition. A model is being developed for the case of deposition in tubes. Deposition velocities are shown using the initial assumptions for solving the model. The deposition of 1 to 28 μ particles was measured in lengths of 0.21, 0.62, 1.152, and 2.81 in. ID aluminum tubes. Uranine or uranine-methylene blue particles of a narrow size range generated with a spinning disc aerosol generator were passed through the tubes. The deposition data are reported as deposition velocities for each tube size as a function of flow rate, or Reynolds number, and particle size.
Author (NSA)

N68-27097# Naval Ship Research and Development Center, Annapolis, Md.

CALCULATION OF REAL GAS EFFECTS IN THE DEPRESSURIZATION OF AN AIR STORAGE CYLINDER

Theo Gordon Keith, Jr. (M.S. Thesis–Md. Univ.) May 1968 102 p refs
(Rept.-2693; AD-669146)

An analytical study was made of the depressurization of air from a highly pressurized (500 to 5000 psi) air storage cylinder through a nozzle when real gas and heat transfer effects are not negligible. A virial coefficient equation of state is used to obtain general expressions for the thermodynamic properties of the gas. These property relationships are used in the numerical solution of the quasi- steady energy equation of the flask air. Results are parametrically compared to the perfect gas situation under various conditions when the virial coefficients of the real gas are those of the Beattie-Bridgeman equation of state. The separate effects of caloric and thermal gas imperfection are evaluated, and it was found that caloric imperfections are small compared to the thermal imperfections. Hence, it was concluded that the specific heats may be used as constants throughout the blowdown without seriously affecting the results. Also, it was found that van der Waals equation of state expressed in the virial equation form gave results which did not differ greatly from the results predicted by the Beattie-Bridgeman equation. Thus, the van der Waal form is preferred in numerical calculations since there is a considerable saving of computing time by using this shorter equation. A series of experiments was run to verify the analytical predictions. The test data compared favorably with the analytical predictions. Differences between the two are attributed, for the most part, to inaccurate heat transfer coefficient prediction and to errors in the temperature measurement. Author (TAB)

N68-27102# Chicago Univ., Ill. Dept. of Geophysical Sciences.

FARADAY WAVES: THE CROSS WAVE RESONANT INSTABILITY

L. F. Mc Goldrick Mar. 1968 59 p refs
(Contract N00014-67-A-0285-0002)
(TR-2; AD-669116)

The paper explains the mechanism through which the transverse waves that are often observed in wave tanks are created. It is shown that regular trains of progressive waves created by any type of wavemaker are unstable to disturbances along their crests, and that the disturbance most often observed has a frequency exactly half that of the progressive waves themselves. A curve of neutral stability is determined analytically and verified experimentally. The stabilizing effects of molecular viscosity are accounted for in an approximate way. The possible relevance of this non-linear subharmonic resonant interaction to the problem of edge wave generation is discussed briefly. Author (TAB)

N68-27103# RAND Corp., Santa Monica, Calif.

INTRODUCTION TO THREE-DIMENSIONAL BOUNDARY LAYERS

Frederick S. Sherman Apr. 1968 105 p refs
(Contract F44620-67-C-0045)
(RM-4843-PR; AD-668753)

The basic concept of a three-dimensional boundary layer is reviewed from both physical and mathematical viewpoints. Emphasis is placed on the various causes of secondary flow, particularly geodesic curvature of the surface streamlines of inviscid flow. Various exact solutions for steady, incompressible laminar flow are reexamined, a proposal for a finite-difference scheme for arbitrary inviscid flows and surface conditions is sketched, and the momentum-integral method and other approximation schemes are briefly discussed. Also considered are compressibility effects, laminar-flow stability, transition to turbulence, displacement thickness of a three-dimensional boundary layer, and the incompressible turbulent boundary layer. It is concluded that very successful three-parameter models of mean velocity profiles exist, but methods for predicting the variation of the profile parameters are essentially deficient. Author (TAB)

N68-27106# Hydronautics, Inc., Laurel, Md.

LATERAL STABILITY AND CONTROL OF HYDROFOIL BOATS

C. C. Hsu Nov. 1967 55 p refs
(Contracts NObs-90224; N00014-67-C-0417)
(TR-463-9; AD-668992)

The prime objectives of the report is to furnish the engineer working in the field of hydrofoil boats with an understanding of the fundamental principles that govern the dynamic characteristics of the hydrofoil boats in lateral motions and with enough detail in providing the basic procedures involved in the calculation of the stability and control characteristics. The equations and method of calculation in the present analysis deal specifically with the inherent lateral motions of hydrofoil boats in calm water for the case of three degrees of freedom (roll, yaw and sideslip) and linear stability derivatives. For cases involving additional degrees of freedom, non-linear derivatives, special equations are required. Author (TAB)

N68-27112# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CALCULATION OF AXISYMMETRIC NOZZLES TAKING INTO ACCOUNT EQUILIBRIUM PHYSICAL-CHEMICAL TRANSFORMATIONS [RASCHET OSESIMMETRICHNYKH SOPEL S UCHETOM RAVNOVESNYKH FIZIKO-KHIMICHESKIKH PREVRASHCHENIY]

U. G. Pirumov, V. A. Rubtsov, and V. N. Suvorva 23 Jun. 1967 19 p refs Transl. into ENGLISH from Univ. Vychislitel'nyy Tsentr. Sb. Rabot (Moscow), No. 2, 1963 p 48–60
(FTD-67-29; AD-668933)

Problems relating to the flow of various gases in a nozzle of given design and to the effects of the physical properties of a gas on the coefficient of impulse loss in a nozzle were studied. The calculations involved axis lined flow of gas through a nozzle of given contour and designs of nozzles with uniform and parallel flow at the nozzle exit. Effects of viscosity and heat transmission were ignored. The study involved axisymmetric nozzles with apex point. The method of characteristics was used in the calculations. The adiabatic line indicator K was 1.207 for the selected composition of gas, designated composition I. Dependence of pressure on density along the line of constant entropy, p = p (rho), is illustrated for that composition. Flows were calculated for two nozzles. Author (TAB)

N68-27139# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

BASES OF GAS DYNAMICS AND THEIR APPLICATION TO THE CALCULATION OF SUPERSONIC WIND TUNNELS

I. A. Panichkin and A. B. Syakhov 12 Jul. 1967 148 p refs Transl. into ENGLISH of the book "Osnovy Gazovoy Dinamiki i ikh Prilozheniye k Raschetu Sverkhzvukovykh Aerodinamicheskikh Trub" Kiev, Izd. Kievsk. Univ., 1965 p 1–152
(FTD-MT-67-66; AD-668292)

A textbook on the fundamentals of gas dynamics and their application to wind tunnel calculations. In part one, entitled one-dimensional motion of an ideal gas the nature of an ideal gas is reviewed and equations pertaining to all aspects of flow are presented. In part two entitled gas dynamics of supersonic wind tunnels the basic characteristics of wind tunnels are described. Various classifications of wind tunnels are discussed in detail. Methods of calculation of gas dynamics are presented in equations. A table of basic gas-dynamical functions for air is included as an appendix. Author (TAB)

N68-27142 Minnesota Univ., Minneapolis.

STABILITY OF VISCOUS PARALLEL FLOWS IN ANNULAR CHANNELS

Julian Edward Mott (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7762

The stability of the fully-developed flow of an incompressible fluid in a concentric annulus to infinitesimal, axially-symmetric disturbances is examined by both asymptotic analysis and finite-difference techniques. Two types of flow are studied: (1) Poiseuille flow in annular cylinders with the radius ratio as a parameter. (2) Flow of a liquid heated at one wall to induce viscosity variations and, through these, a one-parameter family of variations in the velocity profile. Because the velocity profiles are not symmetric, it is necessary in the asymptotic analysis to deal with a two-turning-point problem. For this purpose a simple modification of the single-turning-point analysis is adopted. For the flows treated, the modified, one-turning-point analysis gives results which compare favorably with those obtained by finite differences. Dissert. Abstr.

N68-27148# Aix-Marseilles Univ. (France). Inst. de Mecanique Statistique de la Turbulence.
FINAL SCIENTIFIC REPORT, NUMBER 4
Jan. 1968 48 p refs
(Contract F61052-67-C-0025)
(AFOSR-68-0798; AD-668083)

CONTENTS:

1. ENTROPY OF A TURBULENT GAS: MACROSCOPIC AND TURBULENT PARTS A. J. Favre p 1–9 refs (See N68-27149 16-33)
2. BOUNDARY-LAYER: EXPRESSIONS FOR CELERITIES OF FILTERED FLUCTUATIONS; FIRST MEASUREMENTS FOR TEMPERATURE FLUCTUATIONS. A. Favre, R. Dumas, and E. Verollet p 10–24 refs (See N68-27150 16-12)

N68-27150# Aix-Marseilles Univ. (France). Inst. de Mecanique Statistique de la Turbulence.
BOUNDARY-LAYER: EXPRESSIONS FOR CELERITIES OF FILTERED FLUCTUATIONS; FIRST MEASUREMENTS FOR TEMPERATURE FLUCTUATIONS
A. Favre, R. Dumas, and E. Verollet *In its* Final Sci. Rept., No. 4 Jan. 1968 p 10–24 refs (See N68-27148 16-12)

The equations for filtered space-time velocity correlations in turbulent flow are given and written in terms of celerities. The case of a very norrow band-pass filter is discussed. Measurements of the celerities for velocity and temperature space-time correlation are made, in a boundary layer of a heated plate. They are both larger than the mean velocity of fluid in the inner part of the boundary layer. Author

N68-27154# California Univ., Los Angeles.
SPECTRAL PROPERTIES OF SYSTEMS OF STOKES TYPE
D. H. Sattinger Durham, N. C. AROD 1968 13 p refs
(Contract DA-31-124-ARO(D)-355)
(AROD-5863.15-M; AD-668813)

Topics include: an eigenvalue problem for the linearized system; energy criterion of stability and linearized stability. TAB

N68-27251# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STATISTICAL DISTRIBUTION OF BOLTZMANN AS SOLUTION OF KINETIC EQUATIONS FOR GAS MIXTURES [STATISTICHESKOYE RASPREDELENIYE BOL'TSMANA KAK RESHENIYE KINETICHESKIKH URAVNENIY DLA GAZOVYKH SMESEY]
S. V. Vallander, I. A. Egorova, and M. A. Rydalevskaya *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 69–86 refs (See N68-27244 16-23)

The authors study two principal questions: (a) the type of internal interaction of gas particles which will guarantee the existence of solutions having the form of a Boltzmann distribution; (b) the conditions under which the Boltzmann distribution will be the unique solution. On the basis of a detailed mathematical analysis of the behavior of gas mixture, the authors conclude that certain kinetic equations, which are suitable for gaseous mixtures when there is an interaction between the gas particles and when chemical reactions are allowed to occur, have an equilibrium solution in the form of a Boltzmann distribution. If the mixture being studied is of monatomic gases and the principle of detailed balance holds, then the unique equilibrium distribution, being the solution of the kinetic equation, is the usual statistical Boltzmann distribution. Here the equilibrium distribution is completely determined by the given temperature and the atomic composition of the gases. If the principle of detailed balance is operating in the gaseous mixture but even one polyatomic component is present, then a chemical degeneration of the statistical distribution occurs. Finally, if the principle of detailed balance does not hold during collisions of the gas particles, then, a distribution is established which is different from the Boltzmann distribution. Author

N68-27254# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF LAMINAR BOUNDARY LAYER ON BODIES OF REVOLUTION [RASCHET LAMINARNOGO POGRANICHNOGO SLOYA NA TELAKH VRASHCHENIYA]
L. A. Kulonen *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 110–125 refs (See N68-27244 16-19)

The paper presents a new method for the numerical integration of the equation of laminar boundary layers, based on a combination of the method of lines and the method of successive approximations. The method can be applied to the study of laminar boundary layers in either incompressible or compressible fluids. In the latter case, the flow conditions may be complicated by exchanges of heat and mass, chemical reactions and the heterogeneity of the medium. The treatment is carried out for solids of revolution in an environment of dissociated diatomic gases. Separate sections are devoted to solids of revolution in the presence of a longitudinal pressure gradient, and a cone in a supersonic gas flow. Several examples are given. Author

N68-27255# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CONICAL FLOWS OF IDEAL INCOMPRESSIBLE LIQUID [KONICHESKIYE TECHENIYA IDEAL'NOY NESZHIMAYEMOY ZHIDKOSTI]
N. V. Smirnov *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 126–136 refs (See N68-27244 16-19)

A mathematical treatment of conical flows of an ideal incompressible fluid is presented and certain characteristic singularities of such flows are elucidated. For example, the article treats in detail a flow over a cone of vertex angle $\alpha < \omega$, the axis of which coincides with the positive direction of the axis z, and over two circular cones whose axes coincide with the positive and negative direction of the half axis z. The case when the velocity potential ϕ is independent of r is also considered. The three-dimensional flow obtained by this method may be regarded as flows past conical lattices contained by a spherical rim. In conclusion, the author considers the reduction of the flow over a circular cone $y^2+z^2=x^2$ to a plane problem according to the procedure outlined. Author

N68-27261# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE EXTENSION OF THE CHAPMAN-ENSKOG METHOD TO A REACTIVE MIXTURE OF GASES WITH INTERNAL

DEGREES OF FREEDOM [RASPROSTRANENIYE METODA CHEPMENA-ENSKOG NA SMESI GAZOV S VNUTRENNIMI STEPENYAMI SVOBODY I KHIMICHESKIMI REAKTSIYAMI]
S. V. Vallander, I. A. Egorova, and M. A. Rydalevskaya *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 191–198 refs (See N68-27244 16-19)

The work in this paper differs from earlier work on the topic in two respects: (1) a gas mixture in which chemical exchange reactions can take place is considered, and (2) a different system of macroscopic parameters is chosen to represent the distribution function; in this connection, new macroscopic equations for the determination of these parameters are considered. The starting point for this paper was the notations for the collision integrals; and a form of the equilibrium solution of the corresponding system of Boltzmann equations. Separate sections are devoted to the zero and first approximations. Author

N68-27314# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE INTERACTION OF A REVOLVING CIRCULAR CASCADE OF BLADES AND GUIDE BLADES STREAMLINED BY NONVISCOUS LIQUID [O VZAIMODEYSTVII VRASHCHAYUSHCHEYSYA KRUGOVOY RESHETKI PROFILEY I NAPRAVLYAYUSHCHIKH LOPATOK, OBTEKAYEMYKH NEVYAZKOY ZHIDKOST'YU]
Yu. T. Borshchevskiy 9 Jun. 1967 22 p refs Transl. into ENGLISH from Izv. Sibirsk. Otd. Akad. Nauk SSSR (Novosibirsk), v. 6, no. 2, 1963 p 74-84
(FTD-MT-67-46; AD-668924)

A proposed method for approximate calculation of the influence of a spiral body or guide blades on the operation of a wheel pump with a small number of blades permits approximating the irregularities of pressures on the perimeter of the wheel. In this case theoretical and experimental results agreed quite satisfactorily. Author (TAB)

N68-27452 Brown Univ., Providence, R. I.
ON THE FLOW OF CHARGED PARTICLES
Yeshaiahu Yehuda Winograd (Ph.D. Thesis) 1966 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-2302

In Section I one-dimensional unneutralized flow of charged particles in a bounded system is examined in detail for several flow models. The well-known overlap of steady state solutions, occurring in zero temperature flow approximation, is shown to reappear in the more elaborate flow approximations: collisionless flow and isothermal flow, and is proved to be unstable to infinitely small perturbations. In Section II, a configuration for neutralizing a charged particle beam is examined. A steady state neutralized flow solution is shown to exist, when neutralizing a heavy ion beam with electrons, according to both isothermal and isentropic flow approximations. An effective neutralization length is found when the ion beam velocity is less than the electron speed of sound. A steady state oscillatory solution is obtained when the ion beam velocity is greater than the electron speed of sound. Perturbation analysis for steady state flows which deviate only slightly from a completely neutralized flow is undertaken, and such steady state flows are shown to be stable to an infinitesimal disturbance. Dissert. Abstr.

N68-27462 Wayne State Univ., Detroit, Mich.
LAMINAR, TRANSITION, AND TURBULENT FLOW IN CAPILLARY TUBES
Richard Wilbur Mickelson (Ph.D. Thesis) 1964 209 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-674

An investigation of fluid behavior in capillary tubes showed that a smooth transition from laminar to turbulent flow can be obtained. Moreover, an equation was derived for separating the frictional resistance from the entrance and exit effects in the laminar, transition, and turbulent regions. This equation was verified by experiment. The research showed that in the laminar region the kinetic energy constant fluctuated widely for different tubes, and even for the same tube during different runs. Although the fluctuation is quite large, it is, nevertheless, possible to accurately predict the viscosity of a liquid from plots of the pressure drop versus length of the tubes for constant values of the volume flow rate. Two different mechanisms for the transition from laminar to turbulent flow were observed. For the two longest tubes, the transition was abrupt. For the shorter tubes, a smooth transition occurred. At Reynolds numbers above 8,000 and below 2,000, values for the friction factor were in close agreement with literature values for pipes. However, at Reynolds numbers between 2,000 and 8,000 there was a definite deviation of the friction factor away from the values for pipes reported in the literature. Dissert. Abstr.

N68-27527*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y. Dept. of Aerodynamic Research.
HYPERSONIC TURBULENT BOUNDARY LAYER STUDIES AT COLD WALL CONDITIONS
J. E. Wallace Feb. 1967 35 p refs Presented at 1967 Heat Transfer and Fluid Mech. Inst., La Jolla, Calif., 19–21 Jun. 1967
(Contract NSR-33-009-029)
(NASA-CR-82425) CFSTI: HC$3.00/MF$0.65 CSCL 20D

In this paper the results of a series of shock tunnel experiments on hypersonic turbulent-boundary-layer flow over flat plates with sharp and blunt leading edges and on the wall of a contoured expansion nozzle are presented. The ratio of wall temperature to stagnation temperature ranged from 0.14 to 0.3 on the flat plate and from 0.09 to 0.3 on the nozzle wall. Simultaneous measurements of skin friction and heat transfer were obtained. Comparison of the experimental skin friction results with those obtained using semi-empirical compressible turbulent boundary layer methods indicates best agreement with the method of Spalding and Chi. The experimental heat transfer measurements indicate that under these cold wall conditions the ratio of heat transfer rate to skin friction is smaller than is predicted by current theory. The experimental data are also used to determine corrections to the Crocco relation between the velocity and total enthalpy profiles. These corrections are found to be consistent with direct measurements of total temperature profiles by other investigators. A tentative equivalence is found between the measurements on the sharp flat plate and those on the wall of the contoured nozzle. Author

N68-27553# Hydronautics, Inc., Laurel, Md.
HYDROFOIL CRAFT DYNAMICS IN A REALISTIC SEA INCLUDING AUTOMATIC CONTROL
M. Martin Nov. 1967 105 p refs
(Contracts Nobs-90224; N00014-67-C-0417)
(TR-463-10; AD-668700)

The six degrees of freedom equations of motion of a hydrofoil boat in short crested seas are presented. An attempt was made to make these equations as realistic as feasible by taking into account the more important non-linearities, such as the variations in the wetted area and hydrodynamic coefficients of the struts and surface piercing hydrofoils with submergence changes, changes in hydrodynamic forces and moments resulting from cavitation and ventilation, etc. Equations representing the seaway and the control system are also presented and discussed. Feedback control considerations leading to desirable stability and motions in waves are discussed. Author (TAB)

N68-27579# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NONLINEAR GEOMETRIC ACOUSTICS. WEAK SHOCK WAVES [O NELINEYNOY GEOMETRICHESKOY AKUSTIKE. SLABYYE UDARNYYE VOLNY]
P. F. Koromkov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 47–59 refs (See N68-27575 16-23)

Two nonlinear effects of weak shock waves are considered: (1) the dissipation effect; (2) the effect of supplementary path curvature. Both phenomena are studied in propagation through a nonhomogeneous medium. The derivations of the weak wave effects are developed first for the general case. The remaining sections deal with particular cases, the first of which is the case of small variations in the speed of sound. Other solutions are offered for a variety of limiting conditions and combining of variables. Certain combinations of factors lend themselves to a graphical solution. Author

N68-27583# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPLITTING A STREAM OF LIQUID, STREAMLINED BY A GAS FLOW [O DROBLENII STRUI ZHIDKOSTI, OBTEKAYEMOY GAZOVYM POTOKOM]
V. A. Borodin, L. N. Britneva, Yu. F. Dityakin, and V. I. Yagodkin *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 91–101 refs (See N68-27575 16-23)

The breakup of a cylindrical ideal liquid jet (radius a, density p_1) by the transverse flow another ideal fluid (density p_2, velocity U_0) was studied analytically. Two types of waves propagating along the jet surface were considered: (1) tangential waves deforming the jet in the plane of its cross section; (2) longitudinal waves. Time-dependent potential functions are introduced for the jet and the fluid in cylindrical coordinates. The continuity of the normal component of the velocity at the interface is used as a boundary condition. From Laplace's equation a geralized solution is obtained. Numerical calculations show that a $2 < W < 27.6$ (W=Weber number), four nodal lines appear on the jet surface and two nodal lines at $0.656 < W < 1.24$. To determine the wave propagation along the jet, by substitution in the cylindrical Laplace equation, the solution is obtained in a Bessel function of imaginary arguments. Numerical results are obtained for W=5 and 10. Author

N68-27593# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATION OF FLOW AROUND BLUNTED BODIES BY A FLAT FLOW OF A PLASTIC MEDIUM [EKSPERIMENTAL'NOYE ISSLEDOVANIYE OBTEKANIYA ZATUPLENNYKH TEL PLOSKIM POTOKOM VYAZKO-PLASTICHESKOY SREDY]
I. G. Bulina, V. P. Myasnikov, and V. G. Savin *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 203–211 refs (See N68-27575 16-23)

The problem of a plane stream of viscous-plastic medium flowing around a blunt body has been studied in great detail. The experiments, aimed at determining resistance, were carried out with a specially designed dynamometer. The results obtained agreed well with the theoretical data on the nature of the relationship between drag coefficient of the body and the controlling parameters of the problem. For geometrically shaped bodies (parallelepipeds, cylinders, and wedge-shaped bodies were tested), the γC_a product is a universal function of S_1, which can be determined experimentally on one model and later used to compute the streamlining of bodies having different geometric parameters. The main geometric characteristics of a streamlined body are its maximum thickness and its length. It was found that the drag of wedge-shaped bodies moving in a viscous-plastic medium, unlike the drag of bodies streamlined by a viscous fluid under similar conditions, does not depend upon whether the body moves with its base or its nose forward. Author

N68-27594# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF FLOW AROUND A PLATE BY A LIQUID-DROP LIQUID WITH VARIABLE VISCOSITY [K RASCHETU OBTEKANIYA PLASTINY KAPEL'NOY ZHIDKOST'YU S PEREMENNOY VYAZKOST'YU]
V. P. Kashkarov and A. T. Luk'yanov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 213–217 refs (See N68-27575 16-23)

The solution of the system of equations for the boundary layer of a liquid with variable viscosity flowing in a uniform current around a plate is considered. The initial differential equations are converted to a system of nonlinear finite-difference equations. Their solution can be obtained with the use of static electric integrators whose construction and method of operation are discussed in detail. The solutions for the velocities in the boundary layer along the plate are shown graphically for particular cases. Author

N68-27595# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE THEORY OF NONSTATIONARY SURFACE WAVES [K TEORII NESTATSIONARNYKH POVERKHNOSTNYKH VOLN]
Yu. A. Berezin and V. I. Karpman *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 219–223 refs (See N68-27575 16-23)

A nonsteady-state solution is found for the Korteweg-de Vries equation describing the profile of surface wave of finite but small amplitude at large distances from initial perturbation. Author

N68-27597# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE STRUCTURE OF SHOCK WAVES IN THE CASE OF PHASE TRANSITIONS OF THE FIRST KIND [O STRUKTURE UDARNYKH VOLN V SLUCHAYE FAZOVYKH PEREKHODOV PERVOGO RODA]
N. M. Kuznetsov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 233–236 refs (See N68-27575 16-23)

The author examines the qualitative character of shock-wave structure in the case when $\delta p < 0$, where δp is the pressure difference between the "frozen" and equilibrium branches of the shock adiabatic curve. This examination applies only to strong shock waves, since δp is always positive for weak waves, and nothing new may be learned of the phase transition from it. As the gaseous medium approaches perfect thermodynamic equilibrium, the point defining the state of the medium on the pV plane shifts along a chord of the curve. The density and pressure decrease. The author also considers the case of two-wave configuration when $\delta p > 0$. Author

N68-27598# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FLOW AROUND A ROUND PLATE IN CONDITIONS OF MOLECULAR BOUNDARY LAYER [OBTEKANIYE KRUGLOY PLASTINY V USLOVIYAKH MOLEKULYARNOGO POGRANICHNOGO SLOYA]
V. A. Perepukhov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 237–242 refs (See N68-27575 16-23)

The problem is considered of the flow of a very tenuous gas around a circular plate at a zero angle of attack. The gas molecules are considered as solid spheres of diameter σ. They are assumed to be reflected from the plate by diffusion with a Maxwellian distribution of velocities. The mean free paths for the collisions of various types are as follows. For incident molecules colliding with each other, $\lambda_{11} \approx M_\infty \lambda_0$; for reflected molecules colliding with incident molecules, $\lambda_{21} \approx \lambda_0 / M_\infty$; for incident molecules colliding with reflected molecules, $\lambda_{12} \approx \bar{\lambda}_\sigma$ for reflected molecules colliding with each other, $\lambda_{22} \approx \lambda_\sigma$. Under these conditions, the number of molecules incident on the plate and reflected from it increases until the influx of molecules from infinity not suffering collisions equals the flow of reflected molecules escaping around the edges of the plate. This process is valid for the following relation between the Knudsen and Mach numbers $K_\infty{}^2 > M_\infty > K_\infty > 1$, and the problem can be solved with the theory of first collisions. Author

N68-27599# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

HYPERSONIC FLOW AROUND THIN DULLED BODIES WITH PHYSICOCHEMICAL TRANSFORMATIONS OF GAS IN A HIGH-ENTROPY SHELL [GIPERZVUKOVOYE OBTEKANIYE TONKIKH PRITUPLENNYKH TEL S FIZIKO-KHIMICHESKIMI PREVRASHCHENIYAMI GAZA V VYSOKOENTROPIYNOM SLOYE]

V. V. Lunev *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 243–249 refs (See N68-27575 16-23)

Hypersonic flows over slender, blunt-nosed bodies in the presence of physicochemical transformations in the high-entropy layer are investigated. Two-dimensional and axially symmetric flows are considered and the law of similitude based on the introduction of the effective drag coefficient c_x of the nose is established in order to take account of the effect of physicochemical reactions in the high-entropy layer on flow over bodies. The integral relations of energy and momentum are used to describe flows over slender, blunt-nosed bodies for dissociating air and nonequilibrium flow. The pressure distribution on the body surface, the shapes of shock waves and the distribution of gas parameters outside the high-entropy layer present a general-purpose form, which is independent of equilibrium and nonequilibrium processes taking place in the high-entropy layer. The effective drag coefficients for a sphere and the pressure distributions for a spherically blunted cylinder and a cone in perfect gas flow and in equilibrium dissociating air at $M = 30$ and ∞ are plotted in graphs. The extension of the law of similitude to a blast wave in the atmosphere is discussed. Author

N68-27602# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN METHODS OF INVESTIGATION OF NONSTATIONARY PHENOMENA IN SHOCK TUBES [NEKOTORYYE METODY ISSLEDOVANIYA NESTATSIONARNYKH YAVLENIY V UDARNYKH TRUBAKH]

M. K. Berezkina, A. N. Semenov, and M. P. Syshchikova *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 263–273 refs (See N68-27575 16-23)

An experimental investigation is presented of nonstationary phenomena in shock tubes, such as formation and development of flow near a model generated in a travelling shock wave. The process of flow formation consisting of the reflection and diffraction of shock waves, the formation of a bow shock wave head of a body, the generation and development of a boundary layer, and the formation of flow in the wake of a body are of particular interest to the theory and nonstationary gasdynamic processes and are of great practical value. A detailed description of the shock tube (with a 150×50 mm cross section and m long) and a block diagram of the experimental setup are given and various photographic methods for data recording are outlined. The data obtained make it possible to determine the velocities of the incident shock wave, of the flow of heated and cold regions, and of the contact surface, and also to determine the duration of flow between a shock wave and contact surface, and the Mach number of the flow from the detachment distance of the shock in homogeneous regions of flow. It is also possible to determine the time necessary for a shock wave to reach a steady state, and the dependence of this time on the parameters of the shock wave. Author

N68-27603# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXPERIMENTAL DETERMINATION OF SPEED OF PROPAGATION OF SOUND WAVES IN SATURATED WATER VAPOR AT HIGH PRESSURES [EKSPERIMENTAL'NOYE OPREDELENIYE SKOROSTI RASPROSTRANENIYA ZVUKOVYKH VOLN V NASYSHCHENNOM PARE VODY PRI VYSOKIKH DAVLENIYAKH]

V. I. Avdonin, I. I. Novikov, and Ye. P. Sheludyakov *In its* J. of Appl. Mach. and Tech. Phys. 16 May 1967 p 275–280 refs (See N68-27575 16-23)

A new experimental chamber has been devised for measuring sound velocity at temperatures up to 350°C. Results are compared with those from previous apparatus, where the temperatures overlap based on the method of standing waves. In the new apparatus, a new acoustical resonator made of stainless steel is used. Temperature was measured in the autoclave by a 100-ohm platinum thermometer and by four copper-constantan thermocouples on PMS-48 and PPTN-1 potentiometers, with an accuracy within 0.2°C. Results of measurements on sound velocity in saturated water vapor are shown graphically in Fig. 1 on the enclosure in comparison with an empirical curve. It is seen that the experimental values between 150 and 350°C are in good agreement with the empirical curve, and are in good agreement up to 320°C with the theoretical values proposed by I. I. Novikov (Pokazatel' adiabaty* nasy*shchennogo vodyanogo para. Dokl. AN SSSR, 1948, t. 9, No. 8, str. 1425). At higher temperatures the difference becomes marked, and it is concluded that a factor for transition through the saturation curve must be added to the theoretical calculations. Author

N68-27611*# Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics.

ON THE STRUCTURE OF THE BBGKY HIERARCHY FOR A BOLTZMANN GAS

R. Goldman and E. R. Frieman (Princeton Univ.) [1965] 22 p refs Presented at the Intern. Union of Pure and Appl. Phys., Copenhagen, 11–16 Jul. 1966 Submitted for publication
(Grant NsG-220)
(NASA-CR-75659) CFSTI: HC $3.00/MF $0.65 CSCL 20D

We treat the evolution in time of a spatially uniform Boltzmann gas with no initial correlations. For the case of cut-off potentials and arbitrary initial velocity distribution functions, on using the expansion parameter nr_o^3, with n=particle density and r_o = range of binary potential, we show for terms of the order $(nr_o^3)^2$ and lower that the hierarchy is formally self-closing even with the inclusion of many body effects; i.e., at a given order in (nr_o^3), with the exception of contributions linear in the single particle distribution function of the same order, the binary correlation function which determines the kinetic behavior of the single particle distribution function only depends on functions which themselves are fully determinable within a prescribed iteration procedure. The actual convergence of the various orders of the formal expansion is discussed for initial aribtrary velocity distributions and for linearizations around Maxwellian velocity distributions. Author

N68-27620 Rensselaer Polytechnic Inst., Troy, N. Y.

ON THE UNSTEADY FLOW OF A VISCOUS INCOMPRESSIBLE FLUID FROM A CONICAL RESERVOIR

John Lawrence Way (Ph.D. Thesis) 1966 101 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9298

The unsteady problem of predicting the discharge time for a viscous incompressible fluid from a conical reservoir is investigated. Solution of the related inviscid problem is reviewed, and a new inviscid solution is obtained. Solutions to the viscous problem are obtained by boundary-layer and by one-dimensional analyses. Experimental data is obtained for various fluids ranging in kinematic viscosity from 1 to 700 centistokes. The theoretical discharge times are in reasonable agreement with the experimental results for low and high viscosities, and there is a range of intermediate values of the viscosity where the theories predict lower and upper bounds on the discharge time. A flow visualization experiment was conducted using glycerine as the fluid and it was determined that the flow at the upper range of viscosities considered is of the slow flow type. Dissert. Abstr.

N68-27622# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.

SOME MEASUREMENTS IN THE SELF PRESERVING JET

I. Wygnanski and H. Fiedler Apr. 1968 62 p refs
(D1-82-0712)

The axisymmetric turbulent incompressible and isothermal jet was investigated by use of linearized constant temperature hot wire anemometers. It was established that the jet was truly self preserving some 70 diameters downstream of the nozzle and most of the measurements were made in excess of this distance. The quantities measured include mean velocity, turbulence stresses, intermittency, skewness and flatness factors, correlations, scales, low frequency spectra and convection velocity. The r.m.s. values of the various velocity fluctuations differ from those measured previously as a result of lack of self preservation and insufficient frequency range in the instrumentation of the previous investigations. The energy balance was calculated from the various measured quantities and the result is quite different from the recent measurements of Sami (1967) which were obtained twenty diameters downstream from the nozzle. In light of these measurements some previous hypotheses about the turbulent structure and the transport phenomena are discussed. Some of the quantities were obtained by two or more different methods and their relative merits and accuracy are assessed. Author

N68-27662 California Univ., Los Angeles.

TRANSLATIONAL RELAXATION IN FREE JET EXPANSIONS

Samuel Sturm Fisher (Ph.D. Thesis) 1967 164 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-9650

Molecular velocity distributions are observed in the free expansion of a monatomic gas from a sharp-edged orifice into a vacuum. Observation is made possible by free-molecular sampling of the jet through formation of a "nozzle-source" molecular beam downstream of a skimming probe inserted on the jet centerline. The speed distribution of the molecular beam as a function of angle (with respect to the molecular-beam centerline) is measured by time-of-flight methods. Lower-order moments of the jet molecular velocity distribution at the probe entrance are deduced from the beam measurements. A model for relaxation of these moments is derived, based on Maxwell's transport equation assuming spherical symmetry, hard-sphere molecules, and a functional form of the velocity distribution. This model relates the observed variation of the distribution moments to the effective hard-sphere diameter of the jet molecules. Dissert. Abstr.

N68-27675 Michigan State Univ., East Lansing.

GENERALIZATION OF TAUB'S RELATIVISTIC RANKINE-HUGONIOT EQUATIONS

Ahmed Shawky El-Ariny (Ph.D. Thesis) 1967 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-10517

The present work refers to the relativistic hydrodynamics in the presence of the gravitational field. The velocity of the propagation of signals is assumed to be a variable in accordance with the proposition by Einstein (1907), Fok (1955) and others. The present approach is a generalization of Taub's work in vacuo. The fluid is considered to be a collection of particles in random motion and under the influence of a gravitational field. Only ideal fluid is taken into account. In this case transport physical aspects like viscosity, heat conductivity, etc., are to be disregarded. The flow governing equations (continuity, momentum and energy) are based on the Kinetic theory of gases by means of Boltzmann equation. The space-time based on a variable velocity of propagation of signals is necessarily Riemannian one. Due to the difficulties that arise in establishing solutions of flow problems in the Riemannian space-time, an approximation is suggested by introducing a piece-wise constant velocity of signals. Dissert. Abstr.

N68-27679# Boeing Scientific Research Labs., Seattle, Wash.

FLIGHT SCIENCES LABORATORY REVIEW, 1967

1967 36 p refs

Fluid mechanics of atmospheric motion and shock and shear layers, high energy gas dynamics, and mechanics of low density flows are the general areas for which research activities are reviewed. Work on turbulence is intended to develop for real fluids a statistically detailed but mathematically tractable model of the turbulence, which will lead to usable theories to connect the properties of the turbulence and, in the case of jet noise and radar wakes, with the properties of the scattered signal. Simple shear flows, structure of homogeneous turbulent flow shear, noise, maximum rotational velocities in real vortex motion, interacting flows at high speed, and hypersonic boundary layer transition investigations are summarized. Flow of stratified fluids, structure of turbulence, inertial waves in rotating flows, and inviscid density stratified flow were also investigated; as were combustion in supersonic flow, gas lasers, and atomic and molecular scattering at surfaces. A cumulative bibliography of papers prepared by the Flight Sciences Laboratory is appended. M.W.R.

N68-27686# Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.

HIGHER SHIP SPEEDS DUE TO INJECTION OF NON-NEWTONIAN ADDITIVES

T. Kowalski Jan. 1968 31 p refs Presented in Montreal, Can. 9 Jan. 1968 Supported in part by Defence Res. Board of Can.
CFSTI: HC $3.00/MF $0.65

The presence of minute amounts of the so called non-Newtonian additives to water causes substantial reductions of skin friction drag of bodies. This phenomenon has been confirmed by a number of investigators on a laboratory scale. Application to full size ships is awaiting confirmation of drag reduction at high Reynolds numbers and development of an economical injection technique. Review of laboratory work with non-Newtonian additives is given showing frictional drag reductions of up to 50 per cent. Tests covered included pipe flows and towing tests of flat plates and ship models of destroyer and Mariner type. Present ideas of the possible mechanism of the drag reduction are discussed and this leads to the investigations of the influence of the additive on the turbulence characteristics in the boundary layer. Author

N68-27747# Royal Aircraft Establishment, Farnborough (England).

PASSIVE CONTROL OF A LIQUID IN A ZERO GRAVITY ENVIRONMENT

D. A. Clayton Aug. 1967 39 p refs
(RAE-TR-67207) CFSTI: HC $3.00/MF $0.65

An investigation of the behavior of liquid in a zero gravity environment was necessary to support the work on satellite attitude control systems, which use a liquid propellant stored in equilibrium with its own vapor. This report discusses the hydrostatic and hydrodynamic parameters which are important to the designer and shows how dimensionless parameters may be used to indicate the relative importance of various forces acting upon liquid/vapor systems. Passive control of the fuel, by capillary pumping, is examined and a technique has been developed which ensures liquid over tank outlet during the life of the system. A preliminary investigation of the mechanism of heat transfer in a zero gravity environment is also discussed. Author

N68-27765# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT SYSTEM OF EQUATIONS OF VISCOUS LIQUID IN SPECIAL THEORY OF RELATIVITY [O SISTEME URAVNENIY VYAZKOY ZHIDKOSTI V SPETSIAL'NOY TEORII OTNOSITEL'NOSTI]

N. B. Maslova *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 110–133 refs (See N68-27756 16-23)

A system of equations describing viscous fluid motion within the special theory of relativity is derived from the Boltzmann kinetic equation. The energy momentum tensor is obtained for monatomic homogeneous gas under the assumptions that collisions of the gas particles are elastic, that there are no external forces, and that the phenomena of spontaneous decay are not taken into account. The Enskog method is used for the approximate solution of the relativistic Boltzmann equation. Two forms of energy balance equations are established and compared with those obtained by others. Author

N68-27767# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NORMAL DEGENERATION OF BOUNDARY PROBLEMS [NORMAL'NOYE VYROZHDENIYE KRAYEVYKH ZADACH]

P. Ye. Tovstik *In its* Herald of Leningrad Univ., vol. 18, no. 19, 1963 1 Jun. 1967 p 149–162 refs (See N68-27756 16-23)

For the equation with constant coefficients, consideration is given to the more general case where the supplementary characteristic equation has pure imaginary roots as well as roots with positive and negative real parts. Also considered is the behavior of characteristic numbers of a uniform boundary value problem when the small parameter tends to zero. Author

N68-27773# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SCATTERING OF ATOMS OF GAS ON A ROUGH WALL FORMED BY TWO SCALES OF UNEVENNESS [RASSEYANIYE ATOMOV GAZA NA SHEROKHOVATOY STENKE, OBRAZOVANNOY DVUMYA MASSHTABAMI NEROVNOSTEY]

R. N. Miroshin *In its* Herald of Leningrad Univ., vol. 18, no. 19, 1963 1 Jun. 1967 p 197–201 refs (See N68-27756 16-23)

The problem of the gas atom reflection from the rough surface formed by both large scale and small scale unevenness is solved. It is proved that small scale unevenness is not to be neglected. Author

N68-27820 Rensselaer Polytechnic Inst., Troy, N. Y.

A THEORETICAL STUDY OF NONEQUILIBRIUM FLOWS PAST POINTED BODIES

Zung Sing Chang (Ph.D. Thesis) 1966 145 p

Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-9276

The problems of nonequilibrium supersonic flows past a wedge and a cone with attached shock waves are analyzed by Dorodnitsyn's integral method. The gas may undergo either vibrational or chemical relaxation, and the uniform free stream need not be in equilibrium. The numerical integration of the nonlinear ordinary differential equations obtained by applying the intrgral method is carried out subject to a stability criterion governing the step size. From the behavior of the approximate equations far downstream, it is noted that correct asymptotic values for certain flow variables on the surface cannot be obtained. It is shown that within a region where the flow behind the attached shock wave is subsonic, the solutions are not analytic, and the expansion procedure for the flow variables is no longer valid. If the flow behind the shock is only slightly out of equilibrium, the approximate equations may be further simplified by linearization. The advantage of perturbing about the initial frozen flow rather than the free stream is that the bodies no longer have to be slender and the fluid-mechanical effect is separated from the perturbation scheme. In nonequilibrium flows past pointed bodies, entropy increases acrows the shock, (referred to as the "shock-curvature effect"), as well as due to relaxation phenomena (referred to as the "relaxation effect") may be of importance. For the case where the flow behind the shock is only slightly out of equilibrium, it is found that in the weak-shock limit, the "relaxation effect" is more important, while in the hypersonic limit, the "shock-curvature effect" is more important. Dissert. Abstr.

N68-27821 Rensselaer Polytechnic Inst., Troy, N. Y.

THE SECONDARY FLOW ABOUT A SPHERE ROTATING IN AN ELASTICO-VISCOUS FLUID INSIDE A COAXIALLY ROTATING SPHERICAL CONTAINER

Van Chao Shein Mow (Ph.D. Thesis) 1966 75 p

Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-9291

During the past twenty five years, a number of investigators have formulated idealized equations of state for polymer solutions which exhibit both elastic and viscous properties. A four constant model proposed by Oldroyd in 1958 was used for the present investigation. This work arose from an attempt to devise a viscometric flow such that the constants of the rheological equations of state may be determined. The geometric configuration containing the liquid is the space between concentric spheres, coaxially rotating with different angular speeds. Because of the non-linear nature of the equation of state, it does not appear possible to obtain an exact solution. The method of perturbation was therefore used to obtain the secondary flow solution. Reasonable values for the constants of the equation of state, as reported by Oldroyd and Giesekus, were used to obtain some flow patterns. Computed also are the ratio of moments required to maintain steady rotation of the inner sphere for Newtonian liquids to those of non-Newtonian liquids. Dissert. Abstr.

N68-27835 Princeton Univ., N. J.

MOLECULAR BEAMS FROM FREE JETS OF PURE AND MIXED GASES

Nesim Abuaf (Ph.D. Thesis) 1967 109 p

Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-9589

The seeded beam technique was used in conjunction with thermal energy addition in a nozzle source beam to produce high intensity neutral beams in the 1 to 10 eV energy range. Mean molecular velocities and velocity distributions in the free jet expansion were measured experimentally for several gases and gas mixtures. The studies with helium as the carrier gas at high nozzle Reynolds numbers showed that the measured molecular velocities were in agreement with predictions based on continuum isentropic expansion to high Mach numbers. At lower Reynolds numbers the velocities were observed to depart from the continuum predictions due to the development of a velocity slip between the light and heavy species. The results with hydrogen and hydrogen rich mixtures showed that the variation of specific heat with temperature and the incompleteness of rotational relaxation of the hydrogen molecules must be taken into account. Dissert. Abstr.

N68-27847 Virginia Polytechnic Inst., Blacksburg.

LAWS OF TURBULENT FLOW IN ROUGH PIPES

James Calvin May, Jr. (Ph.D. Thesis) 1967 225 p
Available from Univ. Microfilms: HC $10.15/MF $3.00 Order No. 67-7388

The method which was used to roughen the inside surfaces of the test pipes was described, as was the technique which was used to obtain the resistance measurements for the flow of water through 37 ring and groove patterns of roughness over a range of Reynolds numbers extending from 10^4 to 7×10^5. Analytical and semianalytical procedures were developed to relate the dynamic and kinematic parameters that define a flowing fluid with the geometric parameters that describe a ring and groove pipe geometry. The friction loss incurred during flow over a ring and groove type of wall surface is shown to depend upon the type of vortex system generated at the boundary. Two types of vortex systems are defined, stable and unstable, and both types are discussed in the general framework of the flow regimes defined by Morris. Dissert. Abstr.

N68-27887# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.

SURVEY OF EXPERIMENTAL VELOCITY DISTRIBUTIONS IN VORTEX FLOWS, WITH BIBLIOGRAPHY

Georg K. Timm Nov. 1967 140 p refs
(D1-82-0683; Rept.-126)

Vortex flow is basic to and of great importance throughout fluid dynamics. Experimental data on circumferential velocities in real vortices was determined mostly for vortex flows generated by straight wings and delta wings. A literature search was conducted to collect pertinent data and to present a unified picture of present experimental knowledge. Circumferential velocity distributions in wing vortices determined in four investigations are set forth in which there was an acceptable degree of confidence in the instrumentation techniques and data analysis. A bibliography on vortex flows is also prescribed. Author

N68-27889# National Bureau of Standards, Washington, D. C. Building Research Div.

PERFORMANCE OF SQUARE EDGED ORIFICES AND ORIFICE TARGET COMBINATIONS AS AIR MIXERS

T. K. Faison, Jr., J. C. Davis and P. R. Achenbach 24 Nov. 1967 13 p refs *Its* Building Sci. Ser. 12
GPO: $0.15

A study was made at the National Bureau of Standards to determine the effectiveness of the square-edged orifice, or the orifice in combination with a target for mixing an air stream which was initially nonuniform with respect to temperature. By achieving uniformity of temperature at all points within the cross section of an air stream, instrumentation for measurement might be simplified and a more representative temperature value obtained. Orifices having throat diameters of 8, 12, and 16 in were evaluated in a 24-in circular test duct to determine mixing effectiveness under selected test conditions of temperature distribution and flow rate. Targets 8, 12, and 16 in in diameter in combination with a 12-in orifice were also investigated under similar conditions. Graphic material is presented which illustrates how the orifice and orifice-target combinations perform as mixing devices under selected conditions. Results indicate that the 8-in orifice effectively diminished the nonuniformity of temperature but only at a high pressure drop across the orifice and that a distance of 4.6 duct diameters was required for mixing. Author

N68-27895 Syracuse Univ., N. Y.

UNDEREXPANDED, TWO-DIMENSIONAL JET FLOWS

William James Sheeran (Ph.D. Thesis) 1966 365 p
Available from Univ. Microfilms: Order No. 67-9317

Experimental and analytical investigations of a single, underexpanded, two-dimensional jet flow from a sonic nozzle and the transverse impingement onto it of a side two-dimensional jet were conducted. Shadow-graphic, schlieren and interferometric data were recorded and analyzed. A characteristics solution for the flow field of an underexpanded, two-dimensional jet issuing from a nozzle with uniform exit conditions was developed and programmed. The theoretical centerplane Mach number distribution and the theoretical boundaries of the two-dimensional jets issuing from a sonic nozzle were computed. The effects of the operating pressure ratio on the shock structure of a single, underexpanded, two-dimensional jet flow from a sonic nozzle were recorded. At the higher operating pressure ratios within this range, the location and width of the Riemann wave were examined. The sidewall boundary layer separation and the stability characteristics were also observed. From shadowgraphic and interferometric data, the variation of the higher than ambient pressure in the region of interaction of the jet flows was examined as a function of the relative operating pressures of the two jets. Dissert. Abstr.

N68-28042# Montana State Coll., Bozeman. Dept. of Mechanical Engineering.

AN INVESTIGATION OF TURBULENT FLOW IN A ROUGH PIPE Progress Report, 1 May 1967–30 Apr. 1968

Harry W. Townes 14 Feb. 1968 27 p refs
(Contract AT(45-1)-1954)
(RLO-1954-2) CFSTI: HC$3.00/MF$0.65

The heat transfer coefficient between a solid surface and a moving fluid may be increased by roughening the surface. An investigation was made to determine the basic changes caused by the roughness to the turbulent flow field, the changes which, in turn, cause the increase in heat transfer. In order to conduct the investigation a flow system is necessary. The basic flow system which has been designed and constructed consists of a circular pipe 1 ft in diameter and 70 ft long, an entrance section, fan, return line, and heat exchanger. Air is used as the working medium. Progress to date has been the design and construction of the flow loop, the selection and purchase of the equipment necessary to carry out the investigation, calibration of the hot wire anemometer linearization circuits, a determination of the hot wire probe cross response characteristics, a writing of the computer programs necessary for data reduction and the measurement of several mean velocity profiles in a smooth pipe. Author (NSA)

N68-28180# Rutgers Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering.

TURBULENCE IN FLOWS CONTAINING SUSPENDED SOLIDS

Richard L. Peskin and Philemon S. H. Baw Feb. 1968 79 p refs
(Contract AT(30-1)-2930)
(TR-118-MAE-F; NYO-2930-13) CFSTI: HC$3.00/MF$0.65

Following the Reynolds averaging method of turbulent analysis and Pai's approach to the problem of turbulent flow in a circular pipe, the solid-phase density distribution in gas-solid turbulent pipe flow is found to be controlled by the correlation of axial and transverse particle velocity. Sample measurements of the solid-phase density profile were obtained by optical techniques. An analysis of the apparent particle energy spectrum function was undertaken in addition to the analysis of the effect of particles on the fluid energy spectrum. In universal equilibrium range, the energy spectrum function, E(k), which is obtained by using Pao's hypothesis, decreases at a higher rate than for the case of pure air as k increases. Author (NSA)

N68-28228# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).
ON A VARIABLE NOZZLE FOR LIMITED HOT GAS FLOWS [UEBER EINE VERSTELLDUESE FUER KLEINERE HEISSAGASSTROEME]
K. D. Emmenthal Feb. 1968 19 p ref In GERMAN; ENGLISH summary
(DLR-Mitt.-68-06) CFSTI: HC $3.00/MF $0.65

This paper deals with an infinitely variable convergent nozzle and its performance. The nozzle is watercooled and operated by means of pressurized air. Tests have shown that the nozzle is particularly suitable for hot gas streams up to a working temperature of 1300°C and of limited mass flow. Pictures taken with a high-speed motion camera show that this nozzle, which works without gas spoils, is extremely sensitive to slight and fast pressure alternations. Author

N68-28282*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOCAL AFTERBODY HEAT TRANSFER TO A BLUNT TWO-DIMENSIONAL CONFIGURATION AT MACH 8
Dennis M. Bushnell (M.S. Thesis—Va. Univ.) Washington Jul. 1968 50 p refs
(NASA-TN-D-4443) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Local heat-transfer rates and pressures were measured on a blunt two-dimensional configuration the afterbody of which was subjected to an extensive region of separated flow. The investigation was conducted at a free-stream Mach number of 8 and at free-stream Reynolds numbers based on the model face width of 2 inches (5.08 cm) from 1.27×10^5 to 7.55×10^5. The predictions from two theories were compared with the heat-transfer data obtained in the afterbody region. One of these theories was a constant-pressure integral method utilizing profiles from similar solutions for enthalpy and velocity distributions. The other theory was a local flat-plate method in which the velocity and enthalpy conditions obtained from the integral method in the reverse-flow region were used as effective free-stream quantities. Both theories were in reasonable agreement with the general level of the data. The integral method predicted the correct trend in the vicinity of the separation point, whereas the flat-plate method gave the correct trend over the aft portion of the afterbody. Author

N68-28312# Los Alamos Scientific Lab., N. Mex.
FLOWRATE LIMITS IMPOSED BY THERMAL STRESSES IN STAINLESS STEEL PIPELINES COOLED WITH LIQUID HYDROGEN
Jan K. Novak [1967] 21 p refs Presented at the 2d Intern. Cryog. Eng. Conf., Brighton, Engl., 7–10 May 1968
(Contract W-7405-ENG-36)
(LA-DC-9163; CONF-680501-1) CFSTI: HC $3.00/MF $0.65

A relationship was developed between cooldown flowrate and thermal stress, thus permitting selection of upper flowrate limits to keep the thermal stresses within safe limits. NSA

N68-28315 Pittsburgh Univ., Pa.
CONCERNING RELAXATION OF FLOW AND FLOW BIREFRINGENCE
Wassilij Poppe (Ph.D. Thesis) 1966 188 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-779

The theoretical investigations presented in this dissertation were designed for the following purposes. 1. To obtain expressions for flow relaxation of the velocity and velocity gradient in different types of flow as represented by the apparatuses used for birefringence observation. 2. To apply these expressions for the investigation of the effect of flow persistence on birefringence decay. Theoretical calculations of flow relaxation for two types of flow, the moving boundary flow and the pressure gradient flow, were made. In each case a constant acceleration (starting the flow) and a constant deceleration (stopping the flow) was assumed. A numerical evaluation of one example for every type of flow was performed. Dissert. Abstr.

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N68-26970# Wolf Research and Development Corp., Bladensburg, Md.
GEOMETRIC STATION AND TRAJECTORY ESTIMATION ANALYSIS Final Report, 16 Jan. 1967–17 Jan. 1968
Paul Massiglia 8 Feb. 1968 115 p refs
(Contract F19628-67-C-0221)
(AFCRL-68-0088; AD-668538)

The report presents analysis and describes a computer program to estimate station positions, points on a satellite trajectory, measuring equipment error models, and their 1-sigma uncertainties. Estimation is by the minimum variance technique. Simultaneous observations of topocentric right ascension, declination, and range are acceptable input. A technique is also presented for using the program in an error analysis mode to obtain an estimate to the 1-sigma parameter uncertainties which will accrue from a given geometric measurement configuration—without the use of actual observations. Author (TAB)

N68-26998# Army Map Service, Washington, D. C.
A GENERAL SOLUTION TO THE OPTICAL SATELLITE GEODESY PROBLEM
Frederick W. Fallon 5 Oct. 1967 13 p refs Presented at the 1967 Conv. of the Am. Soc. of Photogrammetry and the Am. Congr. on Surv. and Mapping, St. Louis, 2–5 Oct. 1967
(AD-666238)

A general solution to a geometric network derived from optical observations has been formulated and is being applied to networks of stations in the Near East and the United States. Greenwich Hour Angle and declination are corrected for these effects: precession and nutation of the equatorial reference system, aberration and light-time due to the satellites motion, polar motion, parallactic refraction, and phase effect. The linearized observation equations are solved for corrections to station and satellite positions. This is done iteratively by least squares. In the solution, the observations are appropriately weighted and the minimum conditions for solution are strictly enforced. Author (TAB)

N68-27009# Stanford Research Inst., Menlo Park, Calif.
GEOMAGNETIC DATA: BANGKOK, THAILAND Geophysical Data Report, Oct.–Dec. 1966
Douglas J. Barnes and John Chapman Dec. 1967 17 p
(Contract DA-36-039-AMC-00040(E); Arpa Order 371)
(AD-667958)

Geomagnetic observations are being carried out at the Electronics Laboratory of the Military Research and Development Center, a joint Thailand-United States organization at Bangkok, Thailand. The data contained in bulletin are obtained with rubidium magnetometer. The data base is available int two forms: (1) the continuous magnetogram recording and (2) a digital printout every 2 minutes, both measuring the total geomagnetic field intensity. Author (TAB)

N68-27050# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

QUESTIONS OF ATMOSPHERIC DIFFUSION AND AIR POLLUTION

27 Sep. 1967 39 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ., Vopr. Atm. Diffuzi i Zagryazneniya Vozdukha (Leningrad), no. 172, 1965 p 23–34, 42–47, 74–78
(FTD-MT-24-186-67; AD-668053)

CONTENTS:

1. RESULTS OF ANALYSIS OF EXPERIMENTAL DATA CHARACTERIZING THE DISTRIBUTION OF ATMOSPHERIC POLLUTIONS NEAR THE THERMAL ELECTRIC POWER STATIONS R. I. Onikul, G. A. Panfilov, B. V. Rikhter, and R. S. Gil'denskiol'd p 1–14 refs (See N68-27051 16-13)
2. ANALYSIS OF DISPERSION OF HORIZONTAL OSCILLATIONS OF THE WIND DIRECTION Ye. L. Genikhovich and V. P. Gracheva p 15–22 refs (See N68-27052 16-20)
3. THE QUESTION OF HORIZONTAL SCATTERING OF IMPURITY IN THE ATMOSPHERE V. S. Yeliseyev p 23–29 refs (See N68-27053 16-20)

N68-27051# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RESULTS OF ANALYSIS OF EXPERIMENTAL DATA CHARACTERIZING THE DISTRIBUTION OF ATMOSPHERIC POLLUTIONS NEAR THE THERMAL ELECTRIC POWER STATIONS [REZUL'TATY ANALIZA EKSPERIMENTAL'NYKH DANNYKH, KHARAKTERIZUYUSHCHIKH RASPREDELENIYE ATMOSFERNYKH ZAGRYAZNENIY VBLIZI TEPLOVYKH ELEKTROSTANTSIY]

R. I. Onikul, G. A. Panfilov, B. V. Rikhter, and R. S. Gil'denskiol'd *In its* Question of Atmospheric Diffusion and Air Pollution 27 Sep. 1967 p 1–14 refs (See N68-27050 16-13)

The method for analyzing experimental data on surface concentration of sulfurous gas and ashes is considered, including determination of the quantity of maximum concentration and dangerous speed. Experimental results on pollution near a number of large thermoelectric power stations are in satisfactory agreement with data obtained through the theoretical calculations; and these include dependence of the rise of the chimney torches with the speed of wind. Author

N68-27084# Sheffield Univ. (England). Applied Mathematics and Computing Science Dept.

A THEORETICAL TECHNIQUE FOR EVALUATING THE TIME DEPENDENT EFFECTS OF GENERAL ELECTRODYNAMICAL DRIFTS IN THE F2 LAYER OF THE IONOSPHERE

R. G. Baxter and P. C. Kendall 25 Jan. 1968 37 p refs
(Grant AF-EOAR-64-74)
(AFCRL-68-0172; SR-9; AD-669061)

A technique for solving the full global diffusion equation for the F2 layer, including electrodynamic E x B drift, is presented. This involves considering the form of the diffusion equation in axes moving with the electrodynamic E x B drift. In addition, it is shown how the region of integration, which involves complicated dipole geometry, may be mapped onto a semi-infinite rectangle. The method is illustrated by calculating world curves of electron density for a simple model atmosphere in which the electrodynamic E x B drift and the electron production are time dependent and the loss coefficient is time dependent. The calculations are compared with previous experimental results and confirm electrodynamic lifting as one of the major factors controlling the dip equatorial F2 layer and the associated trough of ionization as suggested by D. F. Martyn. Author (TAB)

N68-27087# California Univ., Livermore. Lawrence Radiation Lab.

A GLOBAL NUMERICAL OCEAN MODEL, PART 1

W. P. Crowley 16 Nov. 1967 40 p refs
(UCRL-50354, Pt 1) CFSTI: HC$3.00/MF$0.65

This report describes a numerical model of the world oceans based on the primitive equations. The model ocean extends from 60° south to 60° north and is global in longitude. Continental boundaries are approximated by connecting mesh points with straight lines. For horizontal motions, the resolution allowed by the mesh is 5 deg. The vertical structure consists of six unevenly spaced layers which vary in size from 0.05 km at the surface to 0.8 km at the bottom. Bottom topography is ignored, but a free upper surface permits the existence of external gravity waves. There are five prognostic variables (temperature, salinity, surface height anomaly, and two horizontal velocity components) which are functions of the four independent variables (latitude, longitude, depth, and time). Diagnostic variables are density anomaly, pressure, and vertical velocity. These are determined from the prognostic variables through an equation of state and the assumptions of hydrostatic equilibrium and incompressibility. Author

N68-27104# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Dept. of Mechanics.

GRAVITY AND ATMOSPHERIC PRESSURE SCALING EQUATIONS FOR SMALL EXPLOSION CRATERS IN SAND

Leon K. Moraski, David J. Teal, Eldon G. Franklin, Stewart W. Johnson, and Jerry A. Smith Mar. 1968 38 p refs Presented at the 6th Ann. Meeting of the Working Group for Extraterrest. Resources, San Antonio, 19–21 Feb. 1968
(AFIT-TR-68-3; AD-668756)

An experimental investigation was conducted to determine the effects of varying gravity and atmospheric pressure on the size of small explosion craters formed in cohesionless sand. The explosives used were commercially available squibs and caps and a linear detonating cord. Gravity was varied by flying the test container in an aircraft through carefully controlled maneuvers to simulate 0.17, 0.38, and 2.5 times terrestrial gravity. Atmospheric pressure was controlled separately by use of a ground-based vacuum chamber. The influence of aircraft vibrations, changes in sand density and moisture content, and techniques of measurement were all considered and evaluated. Author (TAB)

N68-27185# American Meteorological Society, Boston, Mass.

RADAR INVESTIGATION OF DYNAMIC PROCESS IN THE ATMOSPHERE [RADIOLOKATSIONNOE ISSLEDOVANIE DINAMICHESKIKH PROTSESSOV V ATMOSFERE]

A. G. Gorelik and Iu. V. Mel'nichuk Bedford, Mass. AFCRL Mar. 1968 17 p refs Transl. into ENGLISH from Tr. Vses. Nauchn. Meteorol. Soveshch. (USSR), v. 5, 1963 p 318–325
(Contract AF 19(628)-3880)
(T-R-667; AD-669038)

The radar methods employed at present for meteorological purposes are based on the relation between the mean power of the reflected signal and the microstructure of the reflecting object. These methods have been quite fruitful for remote measurement of precipitation intensity as well as for solving problems related to the structure of precipitation etc. However, radar methods can be very useful not only for studying the microstructure of clouds and precipitation, but also for investigating the dynamic processes occurring in the free atmosphere. The present paper is devoted to the development of methods which permit the statistical characteristics of the reflected signal to be related to parameters that characterize the dynamic state of the atmosphere. Author (TAB)

N68-27191# Agricultural Research Service, Ithaca, N. Y. Soil and Water Conservation Research Div.

THE ENERGY BUDGET AT THE EARTH'S SURFACE: A STUDY OF THE CARBON DIOXIDE CONCENTRATION MONITORED OVER AN AGRICULTURAL FIELD NEAR ITHACA, N. Y. Interim Report

L. H. Allen, Jr. Feb. 1968 260 p refs Prepared in cooperation with Cornell University
(Cross Service Order 2-68)
(ECOM-2-681-3; RR-400; AD-667996)

Carbon dioxide concentration was monitored from July to December 1962, and from January to June 1964 over an agricultural field using an infrared CO2 analyzer. Supporting micrometeorological data, including windspeed, incident shortwave radiation, net radiation, air temperature, and soil temperature were taken during part of the monitoring program. The CO2 concentration showed an annual cycling much stronger than has been observed over oceans or at high altitudes. The computed average annual daytime CO2 concentration near the earths surface was 312 ppm. Diurnal cycles in concentration during the summer months frequently showed ranges in excess of 200 ppm. During July, August, and September 1962, the daytime average CO2 concentration at the top of the vegetation (corn) was about 291 ppm. In the diurnal cycle of CO2 concentration the daytime average CO2 concentration was very steady over an individual day, with little or no decrease during the course of a day after the nocturnal build-up had been dispersed or consumed. Incident shortwave radiation had a relatively small effect on CO2 concentration. Nighttime CO2 build-up was found to be directly proportional to mean temperature, soil-to-air temperature difference, and inversely proportional to windspeed. After harvest of the 1962 crop (corn), the diurnal cycle was altered, with a more gradual drawdown of CO2 occurring throughout the daylight period. After snow-cover, diurnal variations became quite small, the typical maximum range being 22 ppm. Author (TAB)

N68-27216 California Univ., Berkeley.

A THEORETICAL INVESTIGATION INTO CERTAIN MICROPULSATIONS IN THE AURORAL ZONE

Douglas Patrick O'Brien (Ph.D. Thesis) 1966 110 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8617

The radiated electromagnetic waves from a line source of current imbedded in an anisotropic inhomogeneous conductor are computed in this dissertation. The line source is an approximation to the polar electrojet current systems flowing in the auroral zone. The anisotropic inhomogeneous conductor represents the local polar ionosphere. A two-dimensional stratified medium is used to approximate the continuous variation of ionospheric parameters such as collision frequencies, gyro-frequencies, and charged particle densities. A spectral enhancement of the radiated fields near f=0.4 cps is predicted for the model ionosphere employed. This enhancement is demonstrated to be the result of standing waves excited by the line current source. These standing waves propagate in a direction parallel to the earth's surface through a low-velocity channel formed by the Alfven wave inversion. This propagation is analogous to the transmission of electromagnetic energy through a dielectric wave guide. It is suggested that the precipitation of energetic electrons is responsible for the modulation of the electrojet system, leading in turn to the formation of these standing wave packets. Dissert. Abstr.

N68-27239 California Univ., Berkeley.

PALEO-INTENSITIES OF THE GEOMAGNETIC FIELD DETERMINED FROM TERTIARY AND QUATERNARY ROCKS

Robert Stephen Coe (Ph.D. Thesis) 1966 412 p
Available from Univ. Microfilms: HC $18.70/MF $5.25 Order No. 67-8543

Thelliers' method was used to determine paleo-intensities of the geomagnetic field from volcanic rocks collected in the western U.S. In this method the natural remanent magnetization (NRM) remaining after each temperature step of thermal demagnetization is compared to the thermoremanent magnetization (TRM) acquired by cooling a sample from the same temperature in a known magnetic field. There are several types of non-ideal behavior which are displayed by rocks in Thelliers' method. The most important in young rocks arises from irreversible changes in the TRM spectrum incurred during heating in the laboratory. Viscous remanent magnetization (VRM) is present in the low blocking temperature portion of the NRM of older rocks. Another disturbing mechanism which has a more serious effect arises from the sample demagnetizing field. Approximate calculations show that the paleo-intensity determined by Thelliers' method could be as much as 15% too high or 33% too low for the most highly magnetic samples. Finally, non-ideal behavior may be inherent in some mechanisms of acquisition of TRM by multidomain magnetic grains. Dissert. Abstr.

N68-27312# Air Force Cambridge Research Labs., Bedford, Mass.

WAVE PROPAGATION IN MATERIALS HAVING FREQUENCY DEPENDENT RHEOLOGICAL PROPERTIES

Ker C. Thomson Mar. 1968 42 p refs *Its* Phys. Sci. Res. Papers No. 354
(PSRP-354; AFCRL-68-0141; AD-669062)

A combined theoretical and model study of the basic physics of wave propagation, as applied to problems in mechanical radiation in the real earth, was conducted. During the support period covered by the report the effort was directed along three primary lines: (A) Improvement and augmentation of the model laboratory, (B) the development of seismic model sources capable of delivering mechanical pulses with broad frequency spectra, and (C) An investigation of the dynamic rheological properties of a model material to be used in the study of wave propagation in an elastic materials. Author (TAB)

N68-27335# Illinois Univ., Urbana. Electrical Engineering Research Lab.

ATLAS OF LUNAR DATA. PLOTS OF IONOSPHERIC FARADAY ROTATION AND ELECTRON CONTENT VERSUS TIME. VOLUME 1: 1961–1962

Harold D. Webb 1962 383 p refs
(Contract DA-28-043-AMC-01710(E))
(AD-668663)

The first volume of an Atlas displays the daily curves of ionospheric electron content obtained from observations of the Faraday rotation of lunar radio echoes. Plane-polarized c-w radio signals at 150.6 Mc were beamed at the moon from the Evans area of Ft. Monmouth, N. J., and received and evaluated by the University of Illinois. Because of an angular ambiquity in the data taken on the one frequency, only variations of electron content relative to an arbitrary level were measured from July 1961 through June 1964. Thereafter, use of a second transmitted frequency of 413.25 Mc permitted resolution of the ambiquity, and absolute values were obtained. The introduction to Volume 1 of the Atlas outlines the theory on which the method is based and describes the receiving equipment and the method of presentation of the data. Author (TAB)

N68-27350# Pennsylvania State Univ., University Park. Ionosphere Research Lab.

IONOSPHERIC RESEARCH Final Report, Mar. 15, 1966–Mar. 14, 1968

David P. Hoult and A. H. Waynick 15 Mar. 1968 18 prefs
(Contract AF 49(638)-1708)
(AFOSR-68-0737; AD-669147)

This report describes research performed under contract AF 49(638)-1708. Included were investigations of the turbulent structure of the D and lower E regions of the ionosphere utilizing electron density-height-time variations obtained with the Arecibo ionospheric observatory backscatter sounder. Associated with this is the attempted determination of horizontal and vertical wave motions, the height of the turbopause and, if possible, the driving mechanisms and sources. This research was one of related efforts underway in the ionosphere research laboratory during the period of interest. A brief history of past work in the laboratory in this field is included. The problems dealt with and the conclusions drawn are described. It is pointed out that several new and important results have been obtained; due in great part to the rather ideal characteristics of the Arecibo facility - especially in comparison with other available experimental techniques or systems. These results include a rather complete description of the turbopause and its height, distinguishing between random dispersive waves and turbulent motions, below the turbopause, and the sources of the waves. A listing of reports, paper publications and presentations are included as well as a personnel listing, both staff and graduate students. Author (TAB)

N68-27352# Air Force Cambridge Research Labs., Bedford, Mass. Terrestrial Sciences Lab.

PLAYA SURFACE MORPHOLOGY: MISCELLANEOUS INVESTIGATIONS

James T. Neal, ed. Mar. 1968 153 p refs *Its* Environ. Res. Papers No. 283

(AFCRL-68-0133; AD-669094)

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2. PLAYA SURFACE CHANGES AT HARPER LAKE, CALIFORNIA: 1962–1967 J. T. Neal p 5–20 refs (See N68-27353 16-13)
3. REPORT OF TEST DRILLING ON ROGERS, COYOTE, ROSAMOND, AND PANAMINT PLAYAS IN 1966 W. S. Motts and D. Carpenter (Mass. Univ.) p 31–57 refs (See N68-27354 16-13)
4. GEOLOGIC CHARACTERISTICS OF SEVEN AUSTRALIAN PLAYAS D. B. Krinsley, C. C. Woo, and G. E. Stoertz (Geological Survey) p 59–103 refs (See N68-27355 16-13)
5. GEOMORPHOLOGY OF THREE KAVIRS IN NORTHERN IRAN D. B. Krinsley (Geological Survey) p 105–130 refs (See N68-27356 16-13)
6. SATELLITE MONITORING OF LAKEBED SURFACES J. T. Neal p 131–150 refs (See N68-27357 16-13)

N68-27353# Air Force Cambridge Research Labs., Bedford, Mass. Terrestrial Sciences Lab.

PLAYA SURFACE CHANGES AT HARPER LAKE, CALIFORNIA: 1962–1967

James T. Neal *In its* Playa Surface Morphol.: Misc. Invest. Mar. 1968 p 5–30 refs (See N68-27352 16-13)

Pronounced surface changes occurred following extensive flooding during the winter of 1965–66. The predominant surface prior to the flooding was soft, dry, and friable silty clay, but reconstitution, combined with the dissolution of salt, resulted in a hard, dry crust. The reconstituted surface shows a substantial increase in strength, although some areas that had changed were showing strength degradation in late 1967, concurrent with an increase in salt accumulation. The observations show that playa surfaces with low salt contents are highly subject to change. The amount of capillary discharge taking place appears to influence the permanency of change. Variation in detrital mineral composition appears less important in controlling surface development than soluble salt content. However, a higher granular content of detrital components tends to favor salt accumulation. Author

N68-27354# Massachusetts Univ., Amherst.

REPORT OF TEST DRILLING ON ROGERS, COYOTE, ROSAMOND, AND PANAMINT PLAYAS IN 1966

Ward S. Motts and David Carpenter *In* AFCRL Playa Surface Morphol.: Misc. Invest. Mar. 1968 p 31–57 refs (See N68-27352 16-13)

(Contract AF 19(628)-2486)

Continuous cores were obtained during a test drilling program in order to study the sedimentology and hydrology of the playa sediments and to learn more about the origin of giant dessication polygons. Cores and sediment samples were taken from test holes ranging in depths from 30 to 275 feet. Soil samples were taken at 5-ft to 10-ft intervals for gravimetric analyses. Water samples were analyzed for chemical constituents. The detailed results of these tests are discussed and illustrated in graphs and charts. K.W.

N68-27355# Geological Survey, Washington, D. C. Military Geology Branch.

GEOLOGIC CHARACTERISTICS OF SEVEN AUSTRALIAN PLAYAS

D. B. Krinsley, C. C. Woo, and G. E. Stoertz *In* AFCRL Playa Surface Morphol.: Misc. Invest. Mar. 1968 p 59–103 refs (See N68-27352 16-13)

Analyses of playa sediments from Western and South Australia suggest that the Tertiary laterite which had been uniformly developed was subjected to erosion in the east due to the Kosciusko Uplift of late Tertiary time. In the west, laterization continued until the climate became arid just after the Kosciusko Uplift. The post-Tertiary arid conditions are reflected in the unweathered detrital feldspars (> 200 mesh fractions). This suggests that the clays rich in kaolinite are inherited products of laterization during the earlier tropical climate. Diagenesis is proposed as an explanation for the direct correlation between the soluble salt and kaolinite content of the clays, while both are inversely proportional to the montmorillinite and chlorite, and have no correlation with illite content. The margins of extensive dune fields covered by recent sediments at Lake Frome, South Australia, are part of the dune system of interior Australia buried at its marine margins by tidal muds. These relationships support the thesis that interior Australia was dry and windy during the Pleistocene when sea level was lower. The recent sedimentary cover represents higher sea level and moister climate. Author

N68-27356# Geological Survey, Washington, D. C. Military Geology Branch.

GEOMORPHOLOGY OF THREE KAVIRS IN NORTHERN IRAN

Daniel B. Krinsley *In* AFCRL Playa Surface Morphol.: Misc. Invest. Mar. 1968 p 105–130 refs (See N68-27352 16-13)

The distribution of three kavirs in northern Iran as well as the presence or absence of peripheral lacustrine deposits suggest that the Pleistocene climate of northern Iran was similar to the present climate, except that the precipitation/evaporation ratio was higher due to decreased summer temperature. This Pleistocene climatic regime resulted in extensive lacustrine expansion at Daryacheh Rezaiyeh (Lake Urmia), and probable expansion at Sabzevar Kavir. At the Great Kavir, where it was cooler and windier but not wetter than at present, there is no evidence that a lake ever existed. Author

N68-27357# Air Force Cambridge Research Labs., Bedford, Mass. Terrestrial Sciences Lab.

SATELLITE MONITORING OF LAKEBED SURFACES

James T. Neal *In its* Playa Surface Morphol.: Misc. Invest. Mar. 1968 p 131–150 refs (See N68-27352 16-13)

Playas are useful as emergency aircraft landing sites and as indicators of the hydrologic environment. A factor that has limited their use is the inability to intermittently monitor surface changes that occur as a result of rain. Reflectance changes that indicate soil moisture or compositional variations (which in turn affect trafficability) have been observed on Gemini color photographs and Nimbus AVCS (Advanced Vidicon Camera System) imagery. The best data currently available is the Gemini color photography; several hundred playas have been photographed in North America, Africa, and Asia. Existing television and infrared imaging systems are marginal for use in observing playas, but systems with improved resolution will provide additional useful data. The use of infrared and false-color films will provide advantages in discriminating moisture variations as well as improving low-visibility conditions. Author

N68-27466*# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.

ROTATION INVARIANT PROBABILITY DISTRIBUTIONS ON THE SURFACE OF A SPHERE, WITH APPLICATIONS TO GEODESY

James E. Potter and Elmer J. Frey May 1967 16 p refs
Presented at the Intern. Colloq. on Dyn. Methods in Satellite Geodesy, Paris 22–26 May 1967
(Grant NSG-254)
(NASA-CR-85742; RE-27) CFSTI: HC $3.00/MF $0.65 CSCL 08E

Gravity anomalies over the geoid are treated as a stationary stochastic process whose spectrum is shown to be positive. A class of linear transforms defined over the surface of a sphere and invariant under rotations is considered and the spectrum of such transforms is defined. The transform of the random process is shown to have its own spectrum which is expressed as a product of the spectra of the original random process and of the transform. Examples of rotation invariant transforms are the transforms which express undulations in an equipotential surface, or deflections of the vertical, or gravity anomalies at the surface. An example is worked out in which it is shown that the convolution expression for the linear transform represented by the Poisson kernel which carries the potential function from one radius to another may be represented by a single integral involving a complete elliptic integral. Author

N68-27543*# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunications Sciences and Aeronomy.

FARADAY ROTATION DISPERSION LOSS AT JICAMARCA

J. P. McClure (Jicamarca Radar Obs.) [1967] 9 p refs
Presented at the Conf. on Thomson Scattering, Urbana, Ill., 10–12 Apr. 1967 Prepared jointly with Jicamarca Radar Obs., Lima
(NASA Order R-06-012-008)
(NASA-CR-86708) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Consideration is given to the problem encountered at the Jicamarca Radar Observatory (JRO) due to a loss mechanism unique to Thompson scatter measurements of Faraday rotation. The really serious type of Faraday dispersion at the JRO is identified as the component from north to south across the scattering volume, perpendicular to the direction of propagation (λ). The amount of disperson at any point in the scattering volume depends only on a geometrical constant times (ω), with the dispersion loss being a monotonically increasing function of ω. Two ways of reducing the effect of Faraday dispersion loss are discussed. In one, the size of the antenna is increased, at least in the north--south direction. Due to the nonlinearity of the dispersion loss, substantial increases in the signal to noise ratio can be obtained. The other method is to transmit and/or receive the magneto-ionic modes on antennas whose phase centers are separated in the north--south direction by a distance sufficient to just cancel the Faraday angle dependence at some large ω. An illustration of this method is given; however, the amount of improvement is considered insignificant. M.G.J.

N68-27555*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.

FALLING SPHERE MEASUREMENTS, 30 TO 120 KM

L. M. Jones and J. W. Peterson Jun. 1967 44 p refs Presented at Am. Meteorol. Soc. Symp., Miami Beach, Fla., 2 Jun. 1967
(Contract NASr-54(05))
(NASA-CR-86707; Rept.-05627-12-S) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Various versions of the falling sphere experiment have been used since 1952. Spheres equipped with sensitive accelerometers and passive, radar tracked, inflated spheres are discussed. Soundings with the latter system are more prevalent and are discussed in some detail. With the best radars, density is measured to 120 km and winds to 70 km. Problems have to do with the effects of vertical wind, anomalous aerodynamic flow and loss of inflation gas. Flight comparisons with grenades, bead thermistors and mass spectrometers are discussed. Results from falling spheres include profiles for model atmospheres, an explosive warming, a tropical survey in all seasons, a southern hemisphere circulation study, a mesopause thermal fine structure study and a study of the vertical scale of stratospheric and mesospheric winds. Author

N68-27562*# Rice Univ., Houston, Tex. Dept. of Space Science.

A SEARCH FOR HELIUM EMISSIONS IN THE AURORAL ZONE

R. H. Eather [1967] 14 p refs Presented at the IQSY/COSPAR Symp., London, Jul. 1967
(Grant NsG-673)
(NASA-CR-85657) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A photometric scanning with a sensitivity of 1R to detect any $\lambda 5876$ HeI emission in the auroral zone was conducted. An emission feature in this region was found to be part of the 8-2 hydroxyl system. Upper limits of 0.02 to 0.003 are placed on the $\lambda 5876/H\beta$ ratio and the corresponding α-particle/proton ratios are calculated as functions of particle energy. Author

N68-27570*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE DISTRIBUTION OF HELIUM AND ATOMIC OXYGEN IN THE LOWER EXPOSURE

Gerald M. Keating and Edwin J. Prior 1967 13 p refs Presented at the 48th Ann. Meeting of the Am. Geophys. Union, Washington, D. C., 17–20 Apr. 1967
(NASA-TM-X-59859) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The authors recently reported that maximum atmospheric densities measured by the Explorer XIX and XXIV satellites occurred in the early afternoon in the winter hemisphere, that is, the hemisphere opposite the equator from the sun. They referred to this density peak as the winter bulge. Previously, it was generally assumed that maximum densities at these altitudes (550 km to 750 km), where atomic oxygen and helium are the primary constituents, would occur in the early afternoon in the summer hemisphere. In the present paper, drag data from the Explorer IX, XIX, and XXIV satellites have been used to obtain a more complete picture of the winter bulge. These data cover the altitude range 390 km to 880 km and the time interval between 1961 and 1966. A correlation is found between the bulge latitude and the inferred helium to atomic oxygen ratio. This correlation indicates that the winter bulge is the result of a high latitude winter helium bulge. Superimposed upon this helium bulge is a near-equatorial summer oxygen bulge. The winter helium bulge occurs in the early afternoon and migrates latitudinally in the opposite sense of the sun from high latitudes in the hemisphere opposite the sun at the solstices to near the equator at the equinoxes. A study of drag data from the Echo II satellite confirms the high latitude winter helium bulge. Author

N68-27571# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.
A SYSTEM CONCEPT FOR HYSURCH (HYDROGRAPHIC SURVEY AND CHARTING SYSTEM)
B. E. Blood, ed., J. B. Searcy, L. S. Wilk, A. C. Conrod, J. Hovorka et al Feb. 1968 515 p refs
(Contract N62306-67-C-0122)
(RE-39; AD-668832)

A preliminary design for a new hydrographic survey and charting system is presented. The new design is characterized by the use of high-speed components and application of automation wherever practicable. The report represents a one-year study of hydrographic survey sensors, navigation, sounding vehicles, and hydrographic-chart production techniques as well as a study of coastal survey strategy. Detailed analyses are presented on all of the subsystems. Since a survey ship is required to carry and support these subsystems, a discussion of the design requirements for such a ship is included. The report concludes with a procurement schedule for a 1971 prototype. Author (TAB)

N68-27591# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SIMILARITY OF SURFACE WAVES DURING EXPLOSIONS IN THE GROUND [O PODOBII POVERKHNOSTNYKH VOLN PRI VZRYVAKH V GRUNTAKH]
S. S. Grigoryan *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 189–194 refs (See N68-27575 16-23)

Discussed are results of experimental study of surface waves formed near the epicenter of shallow sunken explosion in clay ground, and an attempt is made to give with the help of analysis of experimental data generalized empirical relationships, founded on consideration of theory of dimension and similarity. The initial section of surface wave (environment of first entry of seismogram) is subjected to detailed consideration. Author

N68-27615*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GEOLOGIC ORBITAL PHOTOGRAPHY: EXPERIENCE FROM THE GEMINI PROGRAM
Paul D. Lowman, Jr. Jun. 1968 34 p refs
(NASA-TM-X-63244; X-644-68-228) CFSTI: HC $3.00/MF $0.65 CSCL 08B

Most of the Gemini flights carried a terrain photography experiment, whose objective was to obtain small-scale color photographs, with 70 mm hand-held cameras, of selected land and ocean areas for geologic, geographic, and oceanographic research. The experiment was highly successful, with nearly 1100 usable pictures being returned. This paper describes the terrain photography experiment, present specific geologic applications of the Gemini pictures, and discusses the advantages and disadvantages of geologic orbital photography. Specific geologic applications of the Gemini photographs include: (1) study and remapping of part of northern Baja California, Mexico, in the vicinity of the Agual Blanca fault, (2) study of the tectonics and geology of northern Chihuahua, Mexico, in the vicinity of Palomas, (3) unsuccessful search for the Texas Lineament, (4) study of a regional dune-fracture pattern surrounding the Tibesti massif in Chad and Libya, and (5) study of the theory that the Arabian Sea is a sphenochasm, formed by continental drift. Author

N68-27640*# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
TRAVELING DISTURBANCES OBSERVED AT JICAMARCA
D. L. Sterling (Jicamarca Radar Obs.) [1967] 11 p refs
Presented at the Conf. on Thomson Scattering, Urbana, Ill., 10–12 Apr. 1967 Prepared jointly with Jicamarca Radar Obs., Lima
(NASA Order R-06-012-008)
(NASA-CR-85633) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Comparative data are presented on electron density profiles which show the existence, at times, of weak wave-like disturbances in the F region. The profiles, taken every three minutes at Jicamarca with the backscatter radar, were obtained by measuring the Faraday rotation of the scattered signal. The density perturbations from the mean values are on the order of ± 1% to 3%, and the phase varies with height. The oscillation period is roughly 20 minutes. Contour maps showing the wave-like perturbations are included, and comparisons with ionograms show similar disturbances. M.G.J.

N68-27653# Defence Research Board, Ottawa (Ontario). Defence Scientific Information Service.
CAN WE CONTROL THE ARCTIC CLIMATE?
P. M. Borisov May 1968 13 p refs Transl. into ENGLISH from Priroda (Moscow), no. 12, 1967 p 63–73
(T-498-R) CFSTI: HC $3.00/MF $0.65

A plan for creating a transfluence of warm Atlantic water across the Arctic Basin into the Pacific Ocean, as a means of warming the Arctic, is discussed. It is pointed out that if the Arctic Basin can be changed from a dead-end basin to a transit basin for warm Atlantic waters, the marine advection of heat would be regulable over a wide area. It is estimated that the ice cover would be completely liquidated in a period of three years and that climatic improvement would begin from the first year of pumping. It is postulated that climatic changes would probably occur in four stages: (1) The ice cover would disintegrate in summer and reestablish itself slightly in winter, and winters would not be so severe. (2) Seas in the Northern Hemisphere would be ice free year-round, permafrost would vanish, and atmospheric precipitation would increase. (3) Tundra would be eliminated in the northeast part of Eurasia. (4) Broad-leaved forests and aboreal flora would grow on the shores of the Arctic Ocean, and the winter climate of western Europe would become warmer and more stable. A.L.

N68-27664 Denver Univ., Colo.
TRANSIENT PROPAGATION PROBLEMS WITH PLANE BOUNDARIES
Jerome Everett Hahn (Ph.D. Thesis) 1967 122 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-9841

Classical flat-earth propagation problems are formulated in detail. The important feature of these formulations is the use of impulsive, point-source excitation. Laplace transform techniques are used throughout in order to find the time-dependent Green's functions. The vertical electric field produced by the impulsive current between perfect conductors is determined as an introductory problem. Sommerfeld's problem, ground wave propagation, is treated with conductivity as a parameter. It is shown how the dielectric constant governs the vertical electric field in the vicinity of the wavefront for various transient responses (ramp, step and impulse). Lossless-dielectric problems are treated by means of Cagniard's method. The results from this method are used to justify approximations made in finite conductivity problems analyzed by the saddle point method. The expected agreement in the vicinity of the wavefront for zero and nonzero conductivity is verified for surface and elevated sources. The techniques used in the treatment of Sommerfeld's problem are extended to the first reflection from the ionosphere which is assumed to be a perfect magnetic conductor. Dissert. Abstr.

N68-27682* Jicamarca Radar Observatory, Lima (Peru).
ELECTRON, ION AND NEUTRAL TEMPERATURES AT THE MAGNETIC EQUATOR
J. P. Mc Clure, D. T. Farley, Jr., D. L. Sterling, and T. E. Van Zandt [1967] 11 p refs Presented at the Conf. on Thomson Scattering, Illinois Univ., 10–12 Apr. 1967 Sponsored jointly by ESSA and Ist. Geofis. Del Peru
(NASA Order R-06-012-008)
(NASA-CR-85632) CFSTI: $3.00 CSCL 04A

The thermal structure of the equatorial ionosphere is discussed in terms of measurements of electron density and electron, ion, and neutral temperature profiles at the magnetic equator. Major emphasis was on heights of 200 to 500 km, although measurements were made as high as 800 km. Nighttime electron and ion temperatures were found to be equal and constant, which was taken to mean that there was no measurable input of thermal energy at night up to at least 800 km. Nighttime electron densities varied over a wide range. During the day, the ion temperature increased about 100° between 200 and 300 km, and then remained nearly constant to about 450 or 550 km. Electron temperature rose to a maximum value of between 1500 and 2000° at 240 to 260 km, but decreased at approximately 300 to 350 km to become approximately equal to ion temperature. The electron density maximum was usually in the lower half of the isothermal region. From June 1965 to January 1967 the maximum value of Q_e observed at the Jicamarca Radar Observatory increased from approximately 1000 to 4000 eV/cm^3/sec. This parameter may prove to be a more sensitive index of the solar EUV heat flux than presently used parameters such as the 10.7 cm flux. M.W.R.

N68-27683* Jicamarca Radar Observatory, Lima (Peru).

INCOHERENT BACKSCATTER OBSERVATIONS OF THE F REGION DURING THE NOVEMBER 12, 1966 SOLAR ECLIPSE

V. L. Peterson., D. T. Farley, J. L. Green, J. P. McClure, D. L. Sterling et al [1967] 3 p Presented at Conf. on Thomson Scattering, Illinois Univ., 10–12 Apr. 1967 Sponsored jointly by ESSA and Ist. Geofis. del Peru
(NASA Order R-06-012-008)
(NASA-CR-85203) CFSTI: $3.00 CSCL 04A

Electron concentrations and temperatures were measured at heights of 150 to 750 km and 150 to 550 km, respectively, at the Jicamarca Radar Observatory; and measurements were made continuously with a 25 km height resolution to obtain incoherent backscatter observations of the F region during the November 12, 1966, solar eclipse. Preliminary analysis indicates that electron temperature behavior is consistent with the theory of electron heating by elastic collisions with fast photoelectrons and cooling by collisions with ions and neutral particles. Electron temperatures indicate that the neutral temperature decreased by about 100°K during the eclipse. M.W.R.

N68-27702# Defence Research Board, Ottawa (Ontario). Defence Scientific Information Service.

ILLUSORY LAND IN THE ARCTIC

V. S. Antonov May 1968 2 p Transl. into ENGLISH from Priroda (Moscow), no. 12, 1967 p 68
(T-481-R) CFSTI: HC $3.00/MF $0.65

A general note considers discovery of new land masses in polar areas and subsequent inability to locate such "land". Such was the case during an ice reconnaissance flight in the Kara Sea in 1964 when a dome-shaped land mass was observed in the fog. When the aircraft came well down below the overcast, the land had disappeared although along the horizon was a hilly shore-like vision that was impossible to distinguish from the real thing. Such phenomena are considered likely in the Arctic since there is low overcast, small patches of open water producing a "water sky", and the low position of the sun makes for a predominance of red rays. M.W.R.

N68-27793*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA-LRC PROGRAM TO DEFINE EXPERIMENTALLY THE EARTH'S IR HORIZON

J. A. Dodgen, T. B. Mc Kee, and A. Jalink [1967] 28 p refs Presented at the Symp. on Infrared Horizon Sensors for Spacecraft Guidance and Control, El Segundo, Calif., 14–15 Mar. 1967
(NASA-TM-X-59838) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Flight tests were conducted to obtain radiance profile measurements in the spectral intervals most promising for horizon sensor use, and to provide experimental verification of analytical IR radiance profile synthesis techniques. The flight experiments include one conducted on the X-15 research aircraft in which data were obtained in three intervals of the IR Spectrum, and a second experiment in which a suborbital ballistic rocket vehicle was used to obtain measurements in two spectral intervals. Studies were also conducted in order to establish a baseline experiment design for extending the coverage to a global basis, and obtaining sufficient data to ascertain the deterministic and random variations of the radiance profile as a function of geography and season. Data are presented on the flight requirements to meet the experiment objectives and on the feasibility of building and flying a spacecraft system to obtain estimated data. B.S.D.

N68-27809# Library of Congress, Washington, D. C. Aerospace Technology Div.

SATELLITE ALTITUDE DENSITY Surveys of Foreign Scientific and Technical Literature

Daniel W. Michaels Apr. 1968 51 p refs
(ATD-P-68-95-101-2; AD-668757)

The document is a descriptive survey of Soviet literature on the determination of upper air densities from satellite orbit analysis. Author (TAB)

N68-27812 Wisconsin Univ., Madison.

RARE-EARTH ELEMENTS IN BASIC AND ULTRABASIC ROCKS

Frederick August Frey (Ph.D. Thesis) 1967 435 p
Available from Univ. Microfilms: HC $19.60/MF $5.55 Order No. 67-483

The rare-earth elements (lanthanides plus yttrium) comprise a series of elements with similar geochemical properties. They occur as trace elements in all rocks. Rare-earth absolute and relative abundances (distributions) are useful in interpreting geologic phenomena. The rare-earth concentrations and distribution in chondritic meteorities are known to be very constant. Terrestrial sedimentary rocks have higher absolute concentrations than chondrites, but also have a surprisingly uniform rare-earth element distribution. Neutron activation analysis has been used to determine the rare-earth elements in several types of terrestrial rocks. In general, the lanthanide abundances in basic and ultra-basic rocks provide data which can be used as an additional criterion in the evaluation of geologic hypotheses. Dissert. Abstr.

N68-27868# Illinois Univ., Urbana. Electrical Engineering Research Lab.

ATLAS OF LUNAR DATA: PLOTS OF IONOSPHERIC FARADAY ROTATION AND ELECTRON CONTENT VERSUS TIME. VOLUME 2: 1963

Harold D. Webb 1963 254 p ref
(Contract DA-28-043-AMC-01710(E))
(AD-668718)

Plots are presented on the Faraday rotation angle, Ω, and plots of electron content, η, both plotted versus CST and LTASP, for the observations made during the period January 1, 1963 through December 31, 1963. Seasonal averages of η, plotted versus LTASP, are also included. All of the plots are based on relative values of Ω and η. The times of observations for the days of observation are listed. The same information is presented in graphical form. Author

N68-27869*# Pennsylvania State Univ., University Park.

PRESUNRISE HEATING OF THE AMBIENT ELECTRONS IN THE IONOSPHERE DUE TO CONJUGATE POINT PHOTOELECTRONS

M. W. Kwei and J. S. Nisbet [1966] 14 p refs
(Grant NsG-134-61)
(NASA-CR-83671) CFSTI: HC$3.00/MF$0.65 CSCL 04A

In winter, the electron temperature at Arecibo starts to increase prior to local sunrise following illumination of the conjugate ionosphere. The mechanism of this increase is examined. The roles played by heat conduction along the field line and by photoelectrons which traverse the field line are investigated. Detailed analyses are made of the escaping photoelectron flux from the conjugate region including the effect of elastic collisions with neutrals in confining the photoelectrons. Comparisons between the theoretical heat input and observed energy losses of ambient electrons are presented. Also the theoretical and measured heat fluxes are compared. Author

N68-27907# American Meteorological Society, Boston, Mass.

CORRELATION DETERMINATIONS OF IONOSPHERIC DRIFT CHARACTERISTICS [REZUL'TATY OPREDELENIIA KHARAKTERISTIK IONOSFERNYKH DREIFOV KORRELIATSIONNYM METODOM]

L. V. Grishkevich Bedford, Mass. AFCRL Mar. 1968 34 p refs Transl. into ENGLISH from Rezul'taty Issled. Po Programme MGG. Ionosfernye Issled, Sb. Statei Sec. 5 (Ionosfera) (USSR), no. 13, 1964 p 129–150
(Contract AF 19(628)-3880)
(T-R-607; AD-669037)

It is shown that when experimental records of the amplitude fading of signals from the ionosphere are made by the method proposed in (1, 2), the results must be analyzed critically. The paper includes the description of an experiment that permits rather accurate determination of the characteristics of ionospheric drifts with the most general assumptions about the statistical nature of the ionosphere. Author (TAB)

N68-27908# Boeing Co., Seattle, Wash. Geo-Astrophysics Lab.

SOLAR MODULATION CONTROL OF HIGH-LATITUDE RADIO-STAR SCINTILLATIONS AND IONOSPHERIC ABSORPTION

J. M. Lansinger Feb. 1968 29 p refs
(D1-82-0702; AD-669005)

The relationship between high-latitude radio-star scintillation data and riometer ionospheric absorption is investigated. A lead/lag correlation analysis is made of the relationship between these geophysical data and solar data consisting of 10.7 cm radio flux, sunspots and flare index. A statistically significant modulation control is observed to exist between solar activity and the high-latitude absorption and angular scintillation data. The terrestrial data have a tendency to peak some 20 - 30 days following solar activity. Author (TAB)

N68-28088# Atomic Weapons Research Establishment, Aldermaston (England).

INTERPRETATION OF URANOMETRIC ANOMALIES IN ARID REGIONS BY MEANS OF THE U-234/U-238 ISOTOPIC RATIO

N. G. Syromyatnikov, R. A. Ibraev, and F. A. Mukashev [1967] 11 p refs Transl. into ENGLISH from Geokhimiya (Moscow), no. 7, 1967 p 834–841
(AWRE-TRANS-55) CFSTI: HC$3.00/MF$0.65

An isotopic-uranometric technique used for interpreting radioactive anomalies is described that is based on the determination of the uranium content and the E value, which is the anomality of the isotopic ratio U-234/U-238, of mobile uranium in surface formations. These uranium anomalies are either dispersion aureoles of uranium ore manifestations or near-surface accumulations of uranium leached from oreless rocks. Examples are included to confirm the basic feasibility of the technique, which is applicable in prospecting activities and detecting ore-bearing structures in arid regions. M.W.R.

N68-28222*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE RADIATION BALANCE OF THE EARTH-ATMOSPHERE SYSTEM FROM RADIATION MEASUREMENTS OF THE NIMBUS 2 METEOROLOGICAL SATELLITE

Ehrhard Raschke Washington Jul. 1968 81 p refs
(NASA-TN-D-4589) CFSTI: HC$3.00/MF$0.65 CSCL 04A

Measurements of the reflected solar radiation and emitted infrared radiation were obtained over the entire globe from the Nimbus II meteorological satellite during the period from 16 May 1966 to 28 July 1966. From these measurements, the outgoing long-wave radiation flux, the albedo, and the radiation balance of the earth-atmosphere system were computed for five subperiods, each of a half month's length. The global albedo was found to be between 29 and 31 percent, which is less than earlier accepted values of 33 percent and more. The globally emitted long-wave radiation flux results in an equivalent black-body temperature of the planet earth of about 255°K, which is 3–4 degrees higher than was found in earlier studies. The global averages of the radiation balance obtained were between 0.002 cal cm^{-2} min^{-1} of surplus and 0.007 cal cm^{-2} min^{-1} deficit. Author

N68-28226*# National Aeronautics and Space Administration. Washington, D. C.

OBSERVATIONS OF NOCTILUCENT CLOUDS CARRIED OUT IN NOVOSIBIRSK BY THE NOVOSIBIRSK DEPARTMENT OF THE ALL-UNION ASTRONOMICAL GEODETIC SOCIETY IN 1964 [NABLYUDENIYE SEREBRISTYKH OBLAKOV V NOVOSIBIRSKOM OTDELENII VAGO V 1964 GODU]

S. S. Voynov May 1968 3 p Transl. into ENGLISH from Meteorol. Issled. (Moscow), no. 12, 1966 p 111–112
(NASA-TT-F-11526) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The results of the noctilucent cloud observations carried out in Novosibirsk by the Youth Section of the Novosibirsk Department of the All-Union Astronomical Geodetic Society were presented. Author

N68-28242*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.

USING CASCADE ELECTRON-IMAGE CONVERTERS FOR STUDYING INFRARED LUMINESCENCE IN THE UPPER ATMOSPHERE [OB ISPOL'ZOVANII KASKADNYKH ELEKTRONNO-OPTICHESKIKH PREOBRAZOVATELEY DLYA IZUCHENIYA INFRAKRASNOGO SVECHENIYA VERKHNEY ATMOSFERY]

T. I. Toroshelidze and L. M. Fishkova Washington NASA Jun. 1968 7 p refs Transl. into ENGLISH from the Bull. of the Abastumani Astrophys. Obs. (USSR), no. 34, 1966 p 101–107
(Contract NASw-1692)
(NASA-TT-F-11574) CFSTI: HC$3.00/MF$0.65 CSCL 04A

To study the luminescence of the upper layers of the Earth's atmosphere, cascade Electron Image Converters (EIC) have recently been put into use. The special characteristics of the EIC are their high conversion coefficient—the ratio of the current emitted from the screen to the total current striking the photocathode. This property of the cascade EIC is particularly important for studying very weak light currents, such as luminescence of the night and twilight sky. However, usage of cascade EIC's involves definite difficulties. A significant voltage, on the order of 30–60 kilovolts, is needed for their power supply, and thus the insulation problem becomes more complicated. When the conversion coefficient increases, various distortions in the image and also in the noise increase. The principal image distortions include the frequently-observed "pin-cushion" distortion and low linear resolution. Author

N68-28253*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.
THE DETERMINATION OF NOCTILUCENT CLOUD PROJECTION ON THE EARTH'S SURFACE [OPREDELENIYE PROYEKTSII SEREBRISTYKH OBLAKOV NA POVERKHNOSTI ZEMLI]
M. A. Dirikis and Ye. Ye. Mukins NASA May 1967 9 p refs Transl. into ENGLISH from Meteorol. Issled: Serebristyye Oblaka (Moscow), no. 12, 1966 p 52–56
(Contract NASw-1693)
(NASA-TT-F-11522) CFSTI: HC $3.00/MF $0.65 CSCL 04A

For approximate determination of geographic coordinates of noctilucent cloud projections on the earth's surface using single photographs, it is assumed that the height of the clouds is constant and equal to 82 km. A special table is compiled by means of an electronic computer for the purpose of facilitating calculations. Attempts were made to determine horizontal displacements of some details of noctilucent clouds. Various sources of errors of obtained velocities are discussed. Author

N68-28257*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.
INVESTIGATION OF THE HYDROXYL (7.2) BAND IN THE TWILIGHT SKY SPECTRUM [ISSLEDOVANIYE POLOSY GIDROKSILA (7.2) V SUMERECHNOGO SVECHENIYA NEBA]
T. G. Megrelishvili, T. I. Toroshelikze, and I. A. Khvostikov Washington NASA Jun. 1968 8 p refs Transl. into ENGLISH from Bull. Abastumani Astrophys. Obs. (USSR), no. 34, 1966 p 95–100
(Contract NASw-1692)
(NASA-TT-F-11573) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Two lines with wavelengths of 6838 and 6867 Å were found in the twilight sky spectrum with the aid of a transmission spectrograph SP-48. These were identified with the R- and Q- branches of the hydroxyl (7.2) band. The spectrograph was plotted in the spectral range of 5500–6950 Å, which includes only the R- and Q- branches of the (7.2) band. In October, 1964, the long-wave boundary of this range moved to ≈ 7000 Å, which revealed the P- branch as well as the R- and Q- branches on the spectrograms. The radiation lines up to the fourth component of the P- branch of the (7.2) band were identified with certainty. The components of P_5, which have wavelengths of 7005 and 7012 Å, approach the very margin of the spectral sensitivity of the DC film used in the Observatory while carrying out observations according to the IQSY program. Therefore, the components of P_5 were not recorded. Author

N68-28322# Atomic Weapons Research Establishment, Aldermaston (England).
RESEARCH ON VARIATIONS IN THE NATURAL ELECTRIC FIELD IN THE OCEAN
V. S. Solov'ev Mar. 1968 12 p refs Transl. into ENGLISH from Okeanologiya (Moscow), v. 7, no. 4, 1967 p 696–703
(AWRE-TRANS-56) CFSTI: HC $3.00/MF $0.65

The theory of random functions was used to study variations of the natural electric field in the ocean. The basic characteristics of the stationary function, mathematical expectation and correlation function, were determined using a mechanical correlator and electronic computer. Tabulated data are given on a spectral analysis of the variation in the electron field strength which was based on observations of electromagnetic field strength variations in the Artic Ocean. A method is also presented for calculating correlation functions of variations in the northern component of magnetic field strength and the component of electric field strength. It is concluded that this theory provides a key to the solution of various problems relating to the analysis of variations of the electromagnetic field in the ocean. B.S.D.

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N68-27002# Naval Ordnance Lab., White Oak, Md.
A METHOD FOR CLASSIFYING X-RAY FILM
Daniel Polansky and Edward L. Criscuolo 12 Mar. 1968 28 p refs
(NOLTR-68-39; AD-668697)

A study has been conducted to evaluate the parameters that could be used to characterize X-ray film. Factors such as speed, graininess, resolution, contrast and uniformity of emulsion are discussed. Recently developed methods of measuring resolution such as the modulation transfer function will be reviewed. At the present time it is felt that the characteristics of speed and average gradient should form the basis of a film classification system. It is proposed that a contrast-speed index equal to G times the square root of r be used to characterize X-ray film. G is defined as the average gradient between two arbitrary densities d1 and d2, and r is the number of roentgens necessary to produce the density midway between d1 and d2. Author (TAB)

N68-27018# Harry Diamond Labs., Washington, D. C.
AN ADAPTABLE IRIG STANDARD COMMUTATOR
Mark J. Balas Jan. 1968 23 p refs
(HDL-TM-68-3; AD-668652)

A mathematical design for an adaptable IRIG standard commutator based on a ring counter is presented. Operation of a prototype is explained, and complete specifications are included. Author (TAB)

N68-27025# Los Alamos Scientific Lab., N. Mex.
STOP MOTION FLASH PHOTOGRAPHY OF PROJECTILES IN FLIGHT
Paul M. Giles Jan. 1968 12 p
(Contract W-7405-ENG-36)
(LA-3874-MS)

Stop-motion photography of projectiles in flight is a practical method for evaluating artillery weapon components by high resolution pictures when rotational distortion cannot be tolerated. Author (NSA)

N68-27037 Michigan Univ., Ann Arbor.
THE ANALYSIS AND APPLICATION OF HOLOGRAM INTERFEROMETRY
Kenneth Albert Haines (Ph.D. Thesis) 1966 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8264

This dissertation outlines a technique for determining real-time deformation of arbitrary three-dimensional objects. It is well known that interferometric techniques yield extremely accurate measurements of minute surface deformities in mirrors, lenses or highly polished objects. It was previously not possible, however, to use these methods on arbitrary diffuse reflecting objects since a reference wavefront exactly duplicating the object was not available. With the advent of the wavefront reconstruction technique, as described by Leith and Upatnieks, it is now possible to record and reconstruct a wavefront exactly represeptative of the wavefront reflected by the object. This reconstructed wavefront may now be used as a reference against which a very similar second object or the slightly deformed original object may be compared. The analysis of the fringe localization and the information which may be obtained from a measurement of the fringe position and frequency has been carried out. This analysis has been developed from Fresnel diffraction theory as well as from a plane wave decomposition approach. Dissert. Abstr.

N68-27039# Watkins-Johnson Co., Palo Alto, Calif.

RADIO INTERFERENCE MEASURING SET AN/URM-100 (XE-1) Final Report, 26 Jun. 1963–25 Apr. 1967

Robert C. Hilquist Apr. 1968 201 p
(Contract DA-36-039-AMC-02328(E))
(ECOM-02328-F; AD-668940)

Radio Interference Measuring Set AN/URM-100(XE-1) uses low-noise traveling wave tube amplifiers and electronically tuned yttrium-iron garnet preselection filters. Operating over the 1 through 12 GHz range, it is possible to scan up to 5,000 bandwidths (0.1, 1, or 10 MHz each) per second. Four balanced mixers, in the 1-2, 2-4, 4-8, and 8-12 GHz ranges feed the 160-MHz first IF. The 2nd IF includes both 3 parallel 60-MHz amplifiers, having the same gain-bandwidth product, and log and linear amplifiers. Built-in programming uses a 2,000 word memory to store 1,500 frequencies and their associated signal levels. Peak, average, and slideback potentials can be metered, externally exhibited on scope or XY plot, or printed out. Manual and push-button (built-in program) control is possible. Multi-sweep averaging and automatic addition of calibration factors is available. Author (TAB)

N68-27048# Harry Diamond Labs., Washington, D. C.

LIMITATIONS OF THE PAIRED-DETECTOR TECHNIQUE

Lynwood P. Randolph Jan. 1968 17 p refs
(HDL-TM-68-1; AD-668655)

The use of paired detectors to measure time-resolved gamma ray exposure rates and fast neutron flux densities is described. Errors in determining detector sensitivities and measuring detector currents for a given calibation and measurement precision limit this technique to radiation fields defined by certain neutron-to-gamma ratios. The errors in the measured exposure rate and flux density are calculated both generally and for the specific case where the errors in a given type of measurement are assumed to be similar. A FORTRAN computer program is given to assist in data reduction for a linear detector system or one employing a logarithmic current amplifier. Author (TAB)

N68-27064*# Avco Corp., Wilmington, Mass. Missile Systems Div.

DEVELOPMENT OF AN ACOUSTIC FLOW TRANSITION DETECTOR FOR REENTRY SPACECRAFT Final Report

Mar. 1968 140 p refs
(Contract NAS1-7439)
(NASA-CR-66622; AVMSD-0294-68-CR) CSCL 14B

The sensor system was developed to measure the occurrence and progression of turbulent flow over the surface of a vehicle during hypersonic reentry. Physical force is provided by the vorticity of the turbulent flow and transduction is accomplished by a miniature microphone. Electronics were developed to condition the microphone output and provide a system compatible with typical flight test requirements. The concept and hardware were evaluated in wind tunnel and arc facilities to ensure that the system will function successfully in the reentry environment. A typical NASA reentry configuration was selected to provide a reference for analytical work and to provide criteria for the sensor design effort. Estimates of the boundary layer fluctuating pressure spectra and associated shell response of the vehicle were generated to provide criteria for microphone evaluation. Electrical characteristics of the system were designed and tested to be compatible with the power source and data transmission subsystem of the reference vehicle. Author

N68-27078# Ohio State Univ. Research Foundation, Columbus. Aeronautical and Astronautical Research Lab.

LOW PRESSURE MEASUREMENTS IN A HYPERSONIC WIND TUNNEL Interim Report

Frank B. Kroeger Jan. 1968 36 p refs
(Contract AF 33(657)-11060)
(ARL-68-0005; TR-4; AD-669083)

The experience of the past six years in the use of commercially available, variable-reluctance type pressure transducers is presented. The transducers are of the differential type with ranges of 2, 1, 0.5, 0.1, and 0.03 psid and used both at full range and 1/10 range for measuring pressures from 0.0005 to 2.0 psia. The transducers were used for single pressure measurements and combined with a selector valve for multiple pressure measurements, in both cases under various ambient conditions. Repeatability and hysteresis combined were within one per cent of full scale for 1/10 range calibrations. Response to a step function of pressure (from one model tap to the next) was the order of two minutes to a steady value when three feet of 0.047 ID tubing connected the model tap to the transducer. Author (TAB)

N68-27136# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PRINCIPLES OF AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRY

F. V. Drobyshev 20 Jun. 1967 268 p refs Transl. into ENGLISH of the book "Osnovy Aerofotos'yemki i Fotogrammetrii" Moscow, Gosgeoltekhizdat., 1963 p 1–259
(FTD-MT-65-220; AD-668519)

A text book of 8 chapters, 257 pages whose purpose, according to the author, is to outline the basic processes and methods of operation on the creation of topographic maps by means of aerial photos. In addition, the theory and construction of basic aerial photography and photogrammetric instruments are considered. The book is intended as a text for students of optical and mechanical specialities at institutes of geodesy, aerial photography and cartography. Author (TAB)

N68-27213# Aerospace Corp., El Segundo, Calif. Lab. Operations.

THE ATS-1 OMNIDIRECTIONAL SPECTROMETER Final Report, Sep. 1967–Jan. 1968

Mar. 1968 118 p refs
(Contract F04695-67-C-0158)
(TR-0158(3260-20)-7; SAMSO-TR-68-173; AD-669066)

The omnidirectional spectrometer on ATS-1 measures energetic electrons above four integral thresholds (>300 keV, >450 keV, >1.05 MeV, and >1.9 MeV) and energetic protons in two differential channels (5 to 21 MeV and 21 to 70 MeV) by means of solid-state detectors. Analysis of about nine months of electron data shows that during magnetically quiet or moderately disturbed times a diurnal variation in the electron fluxes exists, with the noon-to-midnight ratio being larger for the more energetic electron groups and also, on the average, being larger for magnetically disturbed days. Magnetic storms produce a great deal of fine structure in the electron fluxes, with changes occurring on the time scale of minutes. The effect of such storms is to disrupt the diurnal variation and to depress the electron fluxes. Recovery to pre-storm levels is an energy-dependent process proceeding more sharply for more energetic electrons. Recovery is not smooth, but proceeds in

a stepwise fashion. Modulation of electron fluxes is seen on a six-to-eight-day scale; preliminary data show that these modulations are associated with the sector structure of the interplanetary field. Protons were detected associated with impulsive solar proton events of 28 January 1967, 14 February 1967, and 23 May 1967.
Author (TAB)

N68-27233*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PERFORMANCE PARAMETERS THAT CHARACTERIZE A DIFFERENTIAL-PRESSURE TRANSDUCER

I. Warshawsky and C. C. Gettelman Washington 1968 22 p Presented at the Am. Gas. Assoc. Ann. Transmission Conf., Cleveland, 27 May 1968
(NASA-TM-X-52448) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The parameters that characterize the performance of an industrial transducer are itemized, together with the method of their specification, and the order of magnitude of the limits of error, when applicable. Some techniques of reducing errors and increasing reliability, applicable to the design of the transducer or to its application, are suggested.

N68-27333*# Space Sciences, Inc., Waltham, Mass.

ABSORPTIVITY/EMISSIVITY MEASURING SYSTEMS Summary Final Report

Sol Aisenberg, David Cipolle, James Feather, Gomer Kropa, Joel Newman et al May 1968 69 p refs
(Contract NAS8-20581)
(NASA-CR-61844; SSI-345-SFR) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report describes a flight instrument package designed for the study of the change of energy absorption (absorption, α) and the energy radiation (emissivity, ϵ) of vehicle surfaces during various phases of a space vehicle mission. The measurement is performed by having the test surface mounted on a sample drum and able to rotate into the interior of the measurement instrument where the visible and infrared reflectivity can be measured. The technique for determining the α and ϵ consists of measuring the reflectivities of the surface in the visible and infrared range from which the emissivity and absorptivity are deduced. To measure the total reflected energy from the sample, an integrating sphere is used which permits a simultaneous measurement of absorptivity and emissivity for a single specimen. A special textured (faceted) and highly polished aluminum lining for the integrating sphere has been developed which acts to break the directionality of light after a minimum number of reflections. Because of the high reflectance of Al in the infrared, one textured integrating sphere can be used to measure absorptivity and emissivity at the same time. Author

N68-27367# American Meteorological Society, Boston, Mass.

MEASUREMENT OF THE REFRACTIVE INDEXES OF SYNTHETIC CORUNDUM AND OF THE CORUNDUM CHARGE

N. M. Melankholin *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 26–63 refs (See N68-27363 16-18)

Four methods of measuring the refractive index of corundum and ruby are described, and the relative advantages of each are assessed. In the prism method, which is considered the most exact, a one-circle goniometer is used to measure the refractive index of a prism made from the specimen. The refractometric technique, which yields a fairly high accuracy, is based on the phenomenon of total internal reflection, using a well-polished sample. A disadvantage of both methods is cited as the requirement for specially prepared samples. For measuring corundum, the Obreimov method is suggested for cases where high accuracy is required. The index of the liquid is determined by comparison against the refractive index of a glass reference immersed in the liquid; the comparison is carried out by measuring the phase difference between rays passing through the reference and through the liquid, respectively. Where lower accuracy is permissible, the immersion method can be used. A very small amount of powdered material is immersed in liquids with known refractive indexes. By observing the resulting preparations under the microscope, the liquid closest in refractive index to the solid is selected. M.G.J.

N68-27368# American Meteorological Society, Boston, Mass.

DESCRIPTION OF INSTRUMENTS FOR STUDYING THE COLOR OF CORUNDUM CRYSTALS

S. V. Grum-Grzhimailo *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 64–88 refs (See N68-27363 16-18)

Details are given on instruments designed to investigate the color of corundum crystals, to measure absorption curves, and to determine the color intensity of rubies. These include: (1) a polarizing microscope with a spectroscopic eyepiece for observing the absorption bands of crystals and pleochroism in colored corundum; (2) spectrophotometers for measuring absorption curves; (3) monochromators for isolating a narrow monochromatic beam of a specific wavelength from the spectrum; (4) objective spectrophotometers for measuring the absorption curves of crystals; (5) multistage photometers for visually measuring absorption curves; and (6) a simple instrument layout for determining color intensity of rubies by measuring some quantity that characterizes the absorption of light in them. M.G.J.

N68-27369# American Meteorological Society, Boston, Mass.

ULTRAVIOLET PLEOCHROISM AND ABSORPTION IN CORUNDUM CRYSTALS

S. V. Grum-Grzhimailo and E. S. Rudnitskaia *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 89–112 refs (See N68-27363 16-18)

Light transmission by a corundum specimen in the ultraviolet region of the spectrum was studied with a device consisting of a light source (hydrogen lamp or spark), a rochon prism, a Q-12 quartz spectrograph and quartz focusing lenses. Data comparisons show that not all colored and colorless corundum crystals are pleochroic for ultraviolet rays; many specimens are pleochroic on the shortwave end of their transmission spectrum, while others have enhanced absorption in this region. Studies were also conducted on corundum specimens synthesized with different impurities in order to determine possible causes for the appearance of pleochroism and high ultraviolet absorption in corundum crystals. The findings indicate that for some crystals the enhancement of absorption in the ultraviolet region is due to the presence of ions of the isomorphic impurity; in others, the increase in absorption and pleochroism on the shortwave end is believed related to the appearance of lattice defects that evolved in the crystallization process. Author

N68-27370# American Meteorological Society, Boston, Mass.

FEASIBILITY OF MONITORING THE COMPOSITION OF IMPURITIES IN CORUNDUM BY LUMINESCENCE ANALYSIS

I. I. Antipova-Karataeva and S. V. Grum-Grzhimailo *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 113–123 refs (See N68-27363 16-18)

Details are given on a simple method of luminescence analysis which permits detection of the presence of Cr, Mn, Ti, and V ions in corundums, and an approximate quantitative evaluation of the content of impurities isomorphically entering into the corundum lattice. As ultraviolet rays cause rubies to luminesce with a bright red light, a mercury vapor lamp can be used as the source for exciting the luminescence. The brightness of the luminescence is measured by a visual method, with a comparison photometer used for the visual photometric measurements. A reference specimen is used as a standard. The curves of the brightness of luminescence versus chromium content obtained with the photometer are calibrated against a photometrically measured set of specimens with a known chromium content. An objective method of measuring luminescence brightness is also suggested. In this technique, instead of photometry, a photocell or photomultiplier with a cesium oxide cathode, having maximum sensitivity in the red and near infrared regions of the spectrum, can be used. M.G.J.

N68-27371# American Meteorological Society, Boston, Mass.

PHOTOGRAPHING CORUNDUM

L. I. Tsukerman *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 124–134 refs (See N68-27363 16-18)

Methods for photographing corundum and recording the shape of the boule, its defects, the fracture surface, and the internal stresses in the crystal are described. For the photography, a vertical camera equipped with a lens of focal length, F = 10 or 13.5 cm, is recommended; the light source can be any microscope illuminator. Among the suggestions proposed are the following: (1) The fracture surface and shape of a boule are best photographed in daylight, with the camera near a window. If artificial light is used, milk glass should be placed in front of the lamp, with a flat mirror facing it (beyond the specimen). (2) For photographing optical anomalies such as mosaic structure and plastic deformation in plane-parallel plates, a defect conoscope with the magnifying glass removed can be used. (3) A cuvette filled with an immersion fluid and mounted on a vertically adjustable stage is used to photograph defects inside boules and half-boules. (4) the conoscopic pattern in converging light can be photographed with a microscope, a defect conoscope, or a specially developed device. (5) Watch jewels can be photographed in transmitted or obliquely reflected light, with the photographs taken through a microscope with a 3-power lens. M.G.J.

N68-27387*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A MASS SPECTROMETER-SPECTRUM DIGITIZER SYSTEM FOR THE ANALYSES OF COMPLEX OR LARGE QUANTITIES OF SAMPLES

George M. Wood, Jr. and Robert D. Boies (Consolidated Electrodynamics Corp., Monrovia, Calif.) [1967] 6 p Presented at the 15th Ann. Conf. on Mass Spectrometry and Allied Topics, Denver, 14–19 May 1967
(NASA-TM-X-60139) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The design and testing are described of the equipment for rapidly obtaining and handling data of routine gas analysis. The components are a 180° mass spectrometer with a 150° C inlet system, electrometer detector, and spectrum digitizer providing both magnetic tape and printed paper tape. The operation is briefly described. Sample runs were made, and agreement between computer analysis and operator calculation were considered good. The accuracy of the system was calculated to be better than 1% for significant mass peaks. N.E.N.

N68-27395# Harry Diamond Labs., Washington, D. C.

FLUERIC PRESSURE AND TEMPERATURE-INSENSITIVE OSCILLATOR FOR TIMER APPLICATION

Carl J. Campagnuolo and Stacy E. Gehman Feb. 1968 39 p refs
(HDL-TR-1381; AD-668908)

Three fluid relaxation oscillators using R-C-R feedback loops were tested to establish the feedback resistances required to make the oscillator frequency insensitive to temperature and pressure. The frequency of the three oscillators, geometrically similar but with different feedback resistances, was measured as a function of stagnation pressure and temperature. With modifications guided by these data, one of the oscillators showed frequency variations of less than 2 percent with changes in input pressure of 6 to 30 psig and changes in temperature of 75 to 200F. A theoretical analysis indicates that an oscillator frequency simultaneously insensitive to temperature and pressure can be achieved using a lumped R-C-R network in the feedback loop. Author (TAB)

N68-27416*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ROTATIONAL TEMPERATURE MEASUREMENTS 300°K TO 1000°K WITH ELECTRON BEAM PROBE

William W. Hunter, Jr. [1966] 24 p refs Presented at the ISA 21st Ann. Conf. and Exhibit, New York, 24–27 Oct. 1966
(NASA-TM-X-59966) CFSTI: HC$3.00/MF$0.65 CSCL 20M

Laboratory measurements of rotational temperatures were performed over a 300°K to 1000°K range in static low-density air with an electron beam probe. The accuracy of the measured rotational temperatures was found to be a function of gas number density and temperature. Inclusion of an experimentally determined correction for the gas number density effect enabled measurements to be made with an accuracy that varied approximately from 0 percent to −6 percent with increasing gas temperature. Author

N68-27456*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EFFECTS OF DAMAGE BY 0.8 MeV–5.0MeV PROTONS IN SILICON SURFACE-BARRIER DETECTORS

J. A. Coleman, D. P. Love, J. H. Trainor, and D. J. Williams Jun. 1968 39 p refs
(NASA-TM-X-63242; X-611-68-221) CSCL 20L

Changes in the performance of silicon surface-barrier detectors after irradiation with protons at energies between 0.80 MeV and 5.00 MeV have been investigated for fluences up to 10^{17} protons cm^2. Irradiations of the front, surface-barrier contacts and the rear, ohmic contacts of these transmission detectors were performed. In general, the detector current and noise increased with fluence. When the rear, ohmic contact was irradiated with protons which stopped within the detector, the changes in the current and noise after irradiation were several orders of magnitude smaller than after a similar irradiation of the front contact. For protons with energies greater than about 1 MeV, the detector capacitance decreased at low reverse biases and increased at high biases with increasing fluence. The results indicate that a significant reduction in the increase of detector current and noise can be obtained if the density of radiation-produced defects in the region of the junction is minimized. Author

N68-27460*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CONTROL MOMENT GYRO DEVELOPMENT AND TEST

C. R. Keckler and A. Fontana [1967] 17 p ref Presented at the 1967 SAE Aerospace Systems Conf. and Eng. Display, Los Angeles, 27–29 Jun. 1967
(NASA-TM-X-60126; L-5685) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Extensive research conducted by the Langley Research Center has led to the development of a spacecraft control system employing three control moment gyros (CMG's). This Langley concept has been selected as the baseline control system for the Apollo Telescope Mount (ATM) which is now being developed. A full-scale CMG unit has been procured to determine CMG hardware characteristics and nonlinearities. To evaluate the effects of these nonlinearities on the control capability of a CMG system, the unit has been incorporated into an analog simulation of spacecraft control for the ATM. This paper presents a description of the physical and hardware characteristics of the CMG unit, and discusses results obtained from the system simulations for ATM. These results indicate that the Langley CMG system can meet all ATM spacecraft pointing requirements. Author

N68-27536# Oak Ridge National Lab., Tenn.
INSTRUMENTATION AND CONTROLS DIVISION Annual Progress Report, Period Ending 1 Sep. 1967
G. S. Sadowski, comp. and ed. Feb. 1968 134 p refs
(Contract W-7405-ENG-26)
(ORNL-4219)

The objectives, purposes, and accomplishments of work conducted on various research projects are summarized. These include (1) detectors of ionizing particles and radiation, (2) various facility radiation and contamination alarm systems, (3) support for the high-voltage accelerator program, (4) support for linear accelerator development, (5) reactor instrumentation and controls, (6) support for the in-pile experiments, (7) nanosecond circuitry and techniques, (8) pulse counting and analysis, (9) miscellaneous electronics development, (10) automatic control and data acquisition, (11) data collection and analysis, (12) process instrumentation and control systems engineering, and (13) instrument department maintenance and service. B.S.D.

N68-27557# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.
THE "MANGIASPAGO" SYSTEM OF THE PHYSICS LABORATORY [IL TAVOLO "MANGIASPAGO" DEI LABORATORI DI FISICA]
A. Saffioti 10 Nov. 1967 24 p refs In ITALIAN; ENGLISH summary
(ISS-67/40) CFSTI: HC$3.00/MF$0.65

The Mangiaspago elliptical track measurement system is described, and some preliminary results on its accuracy are presented. Author

N68-27568*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A PHOTOMETRIC TECHNIQUE FOR DERIVING SLOPES FROM LUNAR ORBITER PHOTOGRAPHY
J. J. Lambiotte and G. R. Taylor [1967] 23 p refs Presented at the Conf. on the Use of Space Systems for Planetary Geol. and Geophys. Boston, 25–27 May 1967
(NASA-TM-X-59870) CSCL 14E

To aid in the preliminary evaluation of lunar orbiter data at the Langley Research Center, a computer program and associated technique was developed to derive relative roughness values for the lunar surface from monoscopic high resolution data by photoclinometry. This technique relates measured scene brightness, spacecraft geometry, and a lunar photometric function to determine slope values. In this way hundreds of thousands of slopes have been computed. This paper includes a brief discussion of the photometric model and computer program used, the steps taken to provide necessary calibrations and inputs to the program, and examples of results from the early missions. Also included is an analysis of the validity of the results obtained. Author

N68-27573*# Ohio State Univ., Columbus. Dept. of Geodetic Science.
GRIDDING OF NEAR VERTICAL UNRECTIFIED SPACE PHOTOGRAPHS
Richard H. Rapp and William H. Sprinsky Jun. 1968 45 p refs Prepared for the Geol. Surv., Washington, D. C.
(NASA Order R-09-020-015)
(NASA-CR-95228; NASA-122) CFSTI: HC $3.00/MF $0.65 CSCL 14E

The gridding of unrectified space photographs is described from two viewpoints. The first considers a mathematical model relating points on the surface of the earth to their image on a space photograph. An adjustment procedure is then derived for near vertical photographs. This procedure would allow for the determination of the location and orientation of the space photograph if ground control and approximate values of the parameters are available. The second viewpoint considers that, for many space photographs, the location and orientation parameters of the photograph are not accurately known. A least squares surface fit of the ground control to the coordinates on the photograph is performed. Either viewpoint yields equations that may be used to place grids on the space photographs. Future work is suggested. Author

N68-27574*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FEASIBILITY TESTS OF A RADIOISOTOPE TYPE ABLATION MEASURING SYSTEM
Peter J. Le Bel [1967] 28 p Presented at the Symp. on Radioisotope Appl. in Aerospace, Dayton, Ohio, 15–17 Feb. 1966
(NASA-TM-X-57291) CFSTI: HC$3.00/MF$0.65 CSCL 20M

The feasibility of making continuous measurements of the ablation of a spacecraft heat shield through the use of radioisotopes embedded in the heat shield is presented. The technique consists of selecting two isotopes so that the depletion rate of one will correspond to the recession of the ablating surface and the depletion of the other is a measure of ablative material decomposition. A detector system capable of differentiating between energy levels monitors radiation from each of the two isotopes. Detected counts are integrated and suppled as outputs of the system in a form compatible with the spacecraft telemetry. The results of feasibility tests with Zr–Nb^{95} and In^{114m} sources are presented and the problems encountered in incorporating radioactive compounds into ablation materials are discussed. The application of such a device in reentry vehicle systems may ultimately be limited by the characteristics of available isotopes and the suitability of existing detector systems. Author

N68-27649*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A NONCONTACTING DISPLACEMENT MEASURING TECHNIQUE AND ITS APPLICATION TO CURRENT VIBRATION TESTING
Eugene C. Naumann and Bruce Flagge [1966] 19 p Presented at the Instr. Soc. of Am. 21st Ann. Conf. and Exhibit, New York, 24–27 Oct. 1966 *Its* Preprint no. 16.18-5-66
(NASA-TM-X-59115) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Automated transporting carriages were designed and used to survey the vibrational modes of flat, conical, cylindrical, and complex curvature shell models. The noncontacting displacement measuring system was shown to be capable of accurately defining the dynamic responses of thin shell models. This system consists of three discrete parts, any of which can be easily altered for specific tasks: (1) a position-servoed displacement sensitive transducer; (2) a mechanical transporting carriage for moving the probe about the model; and (3) circuitry which provides a variety of techniques for using the analog signal for direct readout of the results obtained. The system was shown to have excellent frequency stability and to exhibit very high accuracy in terms of the amplitude measured. This technique allows structural research investigators to rapidly measure displacement amplitudes on fragile and irregular shaped structures in the presence of low frequency disturbances. A.L.

N68-27651*# Arkansas Univ., Little Rock. Graduate Inst. of Tech.
CONTRIBUTIONS OF SYSTEM PARAMETERS IN THE DOPPLER METHOD OF FLUID VELOCITY DETERMINATION
Robert Levi Bond (Ph.D. Thesis) 1968 127 p refs
(Grant NGR-04-001-015)
(NASA-CR-95221) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The use of the continuous wave laser for evaluating flow patterns about the base of high thrust rocket engines is described; experiments are limited to simulated flowing systems and flowing liquids. This method permits evaluation with minimal interaction between the photon primary transducer and the flowing system. The coherence and monochromaticity of the laser beam probe permit the mixing of the Doppler frequency-shifted radiation scattered from a dynamic fluid system with a known optical frequency to obtain a low beat frequency that can be detected with opto-electronic devices. The causes of frequency and intensity fluctuations in the distribution function; the size, size distribution, distribution density of the scattering centers; the size and effect of the scattering volume; and certain interactions were investigated and discussed. Major contributions are related to the symmetrical heterodyne arrangement, the understanding gained of the parameters, and to the optimization of the optical heterodyne technique for velocity measurement. A.L.

N68-27671*# Electro-Optical Systems, Inc., Pasadena, Calif.

SOLAR WIND SPECTROMETER PROJECT Final Report, Apr. 1966–Jan. 1968

10 Feb. 1968 107 p Prepared for JPL

(Contracts NAS7-100; JPL-951519)

(NASA-CR-95260; EOS-7069-FR) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The Solar Wind Spectrometer (SWS) is one of four prime scientific experiments that are a part of the Apollo Lunar Surface Experiments Package (ALSEP). The principal goal of ALSEP is to collect scientific and engineering data on the moon's characteristics. ALSEP is one of the few missions emphasizing the collection of lunar scientific data and the only mission requiring astronauts to deploy experiments. On the moon, the astronaut will carry the SWS about 13 feet from the ALSEP data subsystem and will deploy four legs before resting it on the surface. The SWS measures 75-to 9600-eV protons and 10.5-to 1376-eV electrons. It is a compact, self-contained instrument which requires only external power and control signals to provide continuous digital data on solar wind parameters. The SWS overall dimensions are nominally 9 by 10.6 by 11 inches in the stowed (flight) position. Several unique or unusual SWS features are described. Author

N68-27680# Australian National Univ., Canberra. Dept. of Nuclear Physics.

THE USE OF A DOUBLE FOCUSSING SPECTROMETER FOR NUCLEAR REACTIONS AT 180 DEG

R. V. Elliott [1967] 6 p refs

(ANU-P/399) CFSTI: HC$3.00/MF$0.65

A method is presented for setting up a double-focusing spectrometer to detect reaction products at 180° to the beam direction. The beam is brought into the vacuum chamber through the back of a spectrometer via a sliding seal. To account for changes in K (magnetic rigidity of focussed particles/magnetic rigidity of the beam), the spectrometer is rotated about the incoming beam direction on an axis parallel to the z-axis, and this requires a relatively small auxiliary magnet compared to other systems. M.W.R.

N68-27698# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.

THE PRECISION OF THE PHOTOGRAPHIC METHOD FOR X-RAY DIFFRACTION MEASUREMENTS [SULLA PRECISIONE DEL METODO FOTOGRAFICO NELLA DIFFRAZIONE DEI RAGGI X]

M. S. Candeloro 14 Nov. 1967 51 p refs In ITALIAN; ENGLISH summary

(ISS-67/41) CFSTI: HC$3.00/MF$0.65

The most common errors associated with X-ray crystallographic measurements using photographic methods are examined and some improvements in the measuring conditions are deduced. The h01 and 0k1 reflections of a well-known structure are re-examined on the basis of these new considerations and their accuracy is compared with previous results. Author

N68-27848 Purdue Univ., Lafayette, Ind.

CHARACTERISTICS OF HOT WIRE AND HOT FILM SENSORS FOR TURBULENCE MEASUREMENTS IN LIQUIDS

Cheng Lung Liu (Ph.D. Thesis) 1967 188 p

Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-10227

The behavior of two types of sensing elements and of two types of anemometers for turbulence investigations in liquids were studied. They are the Hytemco wire and the quartz coated cylindrical platinum film sensor in conjunction with a Purdue modified Hubbard type CAW and a Heat Flux 1010 constant temperature anemometers. Criteria for the choice of the sensor material and of the fluid medium were derived. The criteria maximize the velocity fluctuation sensitivity with respect to the sensitivity to temperature change of the liquid medium. Dissert. Abstr.

N68-27911*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A UNIQUE ION GUN TO BE USED IN THE STUDY OF ION DETECTORS

Henry A. Lackner and George M. Wood, Jr. [1967] 5 p

Presented at the 15th Ann. Conf. on Mass Spectrometry and Allied Topics, Denver, 14–19 May 1967

(NASA-TM-X-60140) CFSTI: HC$3.00/MF$0.65 CSCL 14B

A prototype ion detector, developed to extend the range of measurement of ion detectors to 10^{-19} amperes, has a positive ion beam that is periodically interrupted for several microseconds, which is the equivalent of superimposing a pulsed negative beam with the same magnitude of charge density and current as the positive beam. The experimental apparatus is essentially a duo-plasmatron that has been modified by increasing the distance between the intermediate electrode and anode, as well as by repositioning the filament nearer the opening in the conical portion of the intermediate electrode. This permits operation at lower than normal pressures and prolongs filament life by reducing arc current. Pulses produced by the detector for several deflection pulse durations are shown. It is noted that the detector method was tested with ion beam energies up to 2000 V with good results; and that the system is being redesigned to include a 36.6 cm detector, improved electronics, and an ion source capable of operation at lower pressures. M.W.R.

N68-27913*# Pennsylvania State Univ., University Park. Materials Research Lab.

MICROPROBE ATTACHMENT FOR QUANTITATIVE STUDIES OF CATHODE LUMINESCENCE

Raymond T. Greer and Eugene W. White [1967] 3 p ref

(Grant NGR-39-009-015; Contract DA-49-083-05A-3140)

(NASA-CR-85151) CFSTI: HC$3.00/MF$0.65 CSCL 09A

A monochromator-photomultiplier attachment to an electron microprobe, developed to study cathode luminescence phenomena, consists of a monochromator housing, a monochromator, an ocular tube, a selection of interchangeable slits, and interchangeable photomultiplier detectors. This attachment replaces the ocular tube of the optical microscope on the microprobe, and obtains a complete spectrum of the luminescent area. The amplified photomultiplier signal can also be displayed on the oscilloscope in a manner similar to the conventional electron backscatter image. Luminescence measurements were made of individual enstatite grains from enstatitic chondrite and achondrite meteorites using electrons of less than 40 keV; and the striking variations of composition and luminescence spectra found within the individual grains indicate the importance of precise localized investigation of a phase assemblage to provide an understanding of the bulk luminescent response of the material. M.W.R.

N68-28017# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
TIME SPREADS OF PULSES GENERATED BY β PARTICLES IN SILICON DRIFTED DETECTORS
M. Moszynski, W. Kurcewicz, and W. Przyborski 1967 35 p refs Presented at the Nanosecond Electron. Conf., Dubna, USSR, Jun. 1967 Submitted for publication
(INR-P-867/IA/E)

Results of the study of the time spreads of pulses from the silicon drifted detectors irradiated by 976 keV ^{207}Bi beta particles at their positive electrode side are presented. A number of 0.8–2.4 mm thick detectors were tested at the room temperature and the liquid nitrogen temperature. Two components of the time spreads have been found to exist; one of them being proportional to the detector pulse rise time and inversely proportional to the reduced average range of beta particles, and another independent of these quantities but characteristic of the individual detector. Initial risetimes of the pulses were determined. The results are in disagreement with predictions of the available theory of charge collection in the detectors. Author (NSA)

N68-28019# Commissariat a l'Energie Atomique, Grenoble (France). Laboratoire de Physique Nucleaire.
POSITION-SENSITIVE DETECTORS FOR CHARGED PARTICLES [LES DETECTEURS A LOCALISATION POUR PARTICULES CHARGEES]
Jean-Marie Helleboid Feb. 1968 25 p refs In FRENCH
(CEA-BIB-102)

In this report, we describe the possibilities of using position-sensitive detectors for charged particles. The circuits associated with several detectors forming a position-sensitive set of detectors are examined. The principle of position-sensitive detectors is reviewed, and the performances as well as the limits of actual realizations are discussed. Author (NSA)

N68-28029# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaire.
CONTRIBUTION TO THE MANUFACTURE OF SILICON SEMICONDUCTOR DETECTORS [CONTRIBUTION A LA FABRICATION DE DETECTEURS A SEMI-CONDUCTEURS AU SILICIUM]
Michel Sandon (Ph.D. Thesis—Grenoble Univ., 23 Oct. 1967) Dec. 1967 77 p refs In FRENCH
(CEA-R-3419)

Production methods used for making silicon semi-conductor detectors at the Nuclear Physics Laboratory in Grenoble are described. Detectors are of two types, either the lithium-compensated p–i–n type up to 3.5 mm thick, or the surface barrier type from 2 mm down to 10μ thick. The research into the surface barrier type concerned essentially the resolving power of the chemical contact obtained by Be evaporation (or Ni deposit), after a chemical attack (type C.P.I.) which is thickness-controlled and which gives a low surface current and a satisfactory flatness. The resolving power obtained (α 8.78 MeV, $T \approx -20°C$) is of the order of 20 keV for thick detectors (surface barrier) and ≈ 50 keV for very thin detectors (10μ), and for p–i–n type detectors (≈50 keV at T + 20°C). Author (NSA)

N68-28045# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
STABILIZATION OF SPECTRA PROVIDED BY A GAMMA RAY SPECTROMETER. APPLICATION TO THE CONSTRUCTION OF A STABILIZER [STABILISATION DES SPECTRES FOURNIS PAR UN SPECTROMETRE A RAYONS GAMMA. APPLICATION A LA REALISATION D'UN STABILISATEUR]
Guy Detourne (Ph.D. Thesis—Paris Univ.) 1967 93 p refs In FRENCH
(CEA-R-3300)

The stabilization of spectra provided by a gamma-ray spectrometer is discussed. It is required to hold the calibration straight line of the spectrometer in a position which is fixed initially to better than 5×10^{-5}/channel. A prototype numerical stabilizer has been constructed: the spectrostab; it is made up of two independent control loops; one of these makes the spectrometer gain depend on the derivatives of a reference peak at high energies; the other makes the origin of the energy scale depend on the derivatives of a second reference peak at low energies. A theoretical study of the behavior of a control loop shows that a direct action stabilizer gives the most accurate stabilization; the loss in resolving power on the theoretical peaks of the spectra attains about 1% with a scintillation detector, and 10% with a semi-conductor detector. Various tests show that the expected results are obtained and that the displacement of the spectral peaks produced by the derivatives are hidden by errors in the calculation of the peak abcissa. Author (NSA)

N68-28087# California Univ., Berkeley. Lawrence Radiation Lab.
ROTATING DISK SYSTEM FOR THE STUDY OF METAL DEPOSITION FROM NONAQUEOUS SOLVENTS
Friedrich G. K. Baucke, Dieter Landolt, and Charles W. Tobias Dec. 1967 32 p refs
(Contract W-7405-ENG-48)
(UCRL-17957) CFSTI: HC$3.00/MF$0.65

A rotating disk electrode system was designed to be used in metal deposition studies from nonaqueous solvents under inert atmosphere. The apparatus consists of a rigidly mounted drive unit and a detachable cell unit, which allows filling of the cell in a dry box while electrochemical measurements are made outside the box. Purification procedures for propylene carbonate and experiments on the deposition of potassium and calcium from propylene carbonate solutions are reported. Author (NSA)

N68-28111# Brookhaven National Lab., Upton, N. Y.
A TOTAL ABSORPTION Ge(Li) GAMMA RAY SPECTROMETER
H. W. Kraner and R. L. Chase [1968] 20 p refs
(BNL-12332; CONF-680207-4) CFSTI: HC$3.00/MF$0.65

A configuration of a large Ge(Li) detector has been developed which suppresses single, local interactions, particularly Compton scatterings. The peripheral n+ contact of a coaxial detector is split into two or more segments, and events are recorded from the central p contact if signals are coincidentally present on two segments of the n+ contact. A sum signal is derived from the central p contact through a high resolution preamplifier, and individual localization signals are taken from each segment of the n+ contact through simple voltage-sensitive preamplifiers. The maximum sensitivity of the system lies between 300 and 1300 keV where the Compton cross-section is dominant and many Compton scattered γ-rays are not sufficiently energetic to escape. The total absorption mode achieves about 20% of the photopeak efficiency of the detector operated in the normal singles mode. An increase in the ratio of the full energy peaks to the Compton continuum of 10:1 is found for ^{60}Co γ-rays, and it is significantly greater for γ-rays of less than 1 MeV. Author (NSA)

N68-28114# Aeroplane and Armament Experimental Establishment, Boscombe Down (England).
ACCEPTANCE TESTS OF PROTOTYPE EPSYLON NOISE DOSE METER
M. A. Beeny 24 Jul. 1967 21 p refs
(AAEE/TECH/360/ENG) CFSTI: HC$3.00/MF$0.65

Laboratory tests were made using pure tones, octave band widths of white noise, and a tape recording of typical jet engine noise. The instrument was found to sum the noise reaching the microphone according to the Burn's criterion (1965), when the ear defender weighting network was not in circuit. When the ear defender circuit was switched into circuit the summation was within limits for exposure times greater than one hour. For times materially less than this the instrument grossly overestimated the effect of the noise on the ear. Author

N68-28123# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

AN ANTICOINCIDENCE-SHIELDED Ge(Li) GAMMA-RAY SPECTROMETER FOR HIGH SENSITIVITY COUNTING

J. A. Cooper, N. A. Wogman, and R. W. Perkins [1968] 12 p refs
Presented at the 11th Scintillation and Semiconductor Counter Symp., Washington, D. C.
(Contract AT(45-1)-1830)
(BNWL-SA-1522; CONF-680207-5) CFSTI: HC$3.00/MF$0.65

An anticoincidence-shielded Ge(Li) gamma-ray spectrometer for high sensitivity counting is described. The system consists of a 20 cc coaxial diode centered inside a 28" diameter by 24" thick plastic phosphor. The source is placed inside the shield and both the coincidence and anticoincidence spectra are recorded simultaneously. The anticoincidence shield reduces the 137Cs Compton edge by a factor of 7.5 to provide a peak to Compton edge ratio of 150:1 without reducing the photopeak efficiency by more than 3%. This system also provides a two to fourfold lower natural radio-nuclide background than similar sized diodes. Author (NSA)

N68-28142# Los Alamos Scientific Lab., N. Mex.

DYNAMIC CHARACTERISTICS OF A SODIUM OXIDE PLUGGING INDICATOR

Charles C. Mc Pheeters and John C. Biery [1968] 4 p refs
Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-eng-36)
(LA-DC-9423; CONF-680601-9) CFSTI: HC$3.00/MF$0.65

The application of a Na_2O plugging indicator as an analytical instrument for indicating O_2 concentrations in liquid Na is presented. The plugging meter was calibrated, and the plugging temperature was correlated with flow rate, cooling rate, and O_2 concentration. NSA

N68-28143# Junta de Energia Nuclear, Madrid (Spain).

DETECTION OF NUCLEAR RADIATION [DETECCION DE RADIACIONES NUCLEARES]

A. Tanarro 1967 106 p In SPANISH
(JEN-183-DF/1-56)

A summary of the lectures about the ordinary detectors of nuclear radiations explained by the author in the courses of nuclear engineering held at the J.E.N. up to the date of publication is given. Those lectures are considered to be a necessary introduction to "Nuclear Instrumentation" and "Applied Electronics to Nuclear Engineering" so it has been intended to underline those characteristics of radiation detectors that must be taken into consideration in choosing or designing the electronic equipment associated to them in order to take advantage of each detector possibility. Author (NSA)

N68-28195# Michigan Univ., Ann Arbor. Dept. of Chemical and Metallurgical Engineering.

THERMAL CONDUCTIVITY OF POTASSIUM VAPOR

Dale E. Briggs (Ph.D. Thesis) Feb. 1968 220 p refs
(Contract AT(11-1)-1352)
(COO-1352-26) CFSTI: HC$3.00/MF$0.65

The purpose of this investigation was to design, construct and operate a high-temperature cell for measuring the thermal conductivity of potassium vapor within the temperature range of 900 to 1400°F. Techniques used to measure thermal conductivity of gases and vapors were reviewed and a parallel plate cell with guard-heated top plate was selected. Molybdenum was selected for the cell material. Thermal conductivity data for superheated potassium vapor were taken at temperatures of 1000, 1100, and 1200°F and a range of pressures of 0.01 to 0.075 atmospheres. As predicted by theory the data show that pressure has a significant effect on the thermal conductivity. Combining theory with experimental results, the increase in thermal conductivity over that for an equivalent non-reacting system at 1100°F was found to be 7 and 42%, for pressures of 0.01 and 0.075 atmospheres, respectively. The thermal conductivity of potassium for an equivalent nonreacting system at 1100°F was calculated to be 0.0074 Btu/hr-ft-°F as compared to measured values of 0.0079, 0.0086, and 0.0105 Btu/hr-ft-°F at pressures of 0.01, 0.03, and 0.075 atmospheres, respectively. Author (NSA)

N68-28266# Aeronautical Research Labs., Melbourne (Australia).

AN EXAMINATION OF THE PRECISION AND CONSTANCY OF FATIGUE METERS

S. I. Nilsson Dec. 1966 15 p
(ARL/SM-315) CFSTI: HC$3.00/MF$0.65

Variability in the counting thresholds of fatigue meters has been examined experimentally. Two aspects of this variability were found: a drift of the thresholds between calibrations and a fuzziness of the threshold, described as a band of uncertainty. The latter is a function of the distance of the threshold from the meter's rest position and is probably related to the rate at which the threshold is crossed in the calibration procedure. Author

N68-28269# United Kingdom Atomic Energy Authority, Harwell (England). Ceramics Div.

X-RAY MICROSCOPY APPLIED TO MATERIALS SCIENCE, INCLUDING DIVERGENT BEAM ANALYSIS: BIBLIOGRAPHY

P. J. Baldock Feb. 1968 43 p refs
(AERE-R-5729) CFSTI: HC$3.00/MF$0.65

A bibliography on X-ray microscopy as a technique in materials research and industrial applications includes studies on divergent beam analysis. Arranged chronologically with references as early as 1895, the bibliography includes general references and related bibliographies; as well as data on contact and protection microradiography, reflection microscopy from mirror and crystal surfaces, and imaging by wavefront construction. Diffraction, image recording, and stereoscopic techniques are also referenced; and an author index is included. M.W.R.

N68-28273# Aeronautical Research Labs., Melbourne (Australia).

A VERSATILE PRESSURE RECORDING SYSTEM

R. W. Thompson Feb. 1967 39 p
(ARL/A-285) CFSTI: HC$3.00/MF$0.65

A system for direct plotting of pressures measured in the 9' × 7' low speed wind tunnel was developed. The equipment described drives several pressure scanning instruments, in each of which pressures are measured by a transducer. The equipment processes the transducer electrical outputs and passes them to an X–Y recorder, so that pressures measured from numerous stations are each plotted in discrete positions. Facilities provided include the omission of readings from particular stations if desired, variation of the rate of scanning, automatic change of the plotting symbol, numerical indication of the pressure station under test, and provision for connection to a digital readout system. Author

N68-28291# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

STUDY OF THE PROBLEMS ARISING FROM THE USE OF THERMAL NEUTRON DETECTORS IN A PULSED REGIME

APPLICATION TO THE DEVELOPMENT OF A DIGITAL TRANSFEROMETER [ETUDE DES POSES PAR L'UTILISATION DES DETECTEURS DE NEUTRONS THERMIQUES EN REGIME IMPULSIONNEL. APPLICATION A LA REALISATION D'UN TRANSFEROMETRE NUMERIQUE]
Yves Le Tilly (Ph.D. Thesis) Dec. 1967 77 p refs In FRENCH
(CEA-R-3241)

The instantaneous value of the counting rate of the pulses given by a fission detector settled in a reactor follows the neutron flux, but it is shown that the counter adds a white noise to the measured signal. This report deals with some possibilities of on-line numerical handling afforded by this kind of signal. The influence of an N-numerical divider is considered, and it is shown that, acting like a quantifier, it adds to the signal a white noise with the power $N^2/12$. One studies afterwards the principle of a digital filter aimed to Fourier analyse the signal. The realization of this device is described. It can be used in transfer function measurements of frequencies below 125 kHz. Some examples of experiments performed with this apparatus are presented. The design, according to the same principle, of a power spectral density analyser in the frequency range 0.01–10,000 Hz for random signal of the same kind is discussed. Author (NSA)

N68-28296# United Kingdom Atomic Energy Authority, Harwell (England). Electronics and Applied Physics Div.
A PROPOSED LOW-SIGNAL RADIATION DETECTOR INCORPORATING INTERNAL MULTIPLICATION
P. E. Gibbons Mar. 1968 9 p refs
(AERE-M-2025) CFSTI: HC$3.00/MF$0.65

A proposed form of semiconductor detector for the measurement of photons and particles with energies of a few KeV is described. The device, which also could act as an infrared photodetector, would utilise avalanche multiplication. The effect of device parameters on gain and energy resolution is discussed. Ion implantation techniques will probably assist the practical implementation of this device. Author

N68-28308*# Maryland Univ., College Park. Computer Science Center.
THE PAX II PICTURE PROCESSING SYSTEM
James W. Snively, Jr. and Edgar B. Butt May 1968 94 p refs
(Grant NsG-398; Contract NIH PH-43-67-1099)
(NASA-CR-95375; TR-68-67) CFSTI: HC $3.00/MF $0.65 CSCL 14E

PAX 2, a revised and expanded version of an IBM 7090/94 program that performs operations on digital pictures, is a collection of subroutines which may be called by a program written in Fortran. The pictures operated on by PAX 2, except for several computer dependent restrictions, are arbitrary in size and number. Fast access external storage can be used in conjunction with PAX 2, which has been implemented on the IBM 7094, IBM 360, and Univac 1108 computers. The planes, windows, stacks of planes, shifting, directions and direction lists, data structure, and labeled common are detailed for PAX 2; and indexes of user and system subroutines are included along with the key to subroutine parameters, user subroutines classified by function, and assembly language subroutines listing. Each of the subroutines is documented. M.W.R.

N68-28327*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PRECISION SPACECRAFT RADIOMETER FOR HECTOMETER WAVELENGTHS
C. R. Somerlock and J. Krustins Washington Jul. 1968 24 p refs
(NASA-TN-D-4634) CFSTI: HC$3.00/MF$0.65 CSCL 20F

The Radio Astronomy Explorer program at Goddard Space Flight Center has pointed out the need for sophisticated radio astronomy receivers for spacecraft use. Development of such a receiver is described with design details. The resulting instrument is a feedback radiometer of the Ryle-Vonberg type. It measures at nine different frequencies between 0.4 Mc and 10 Mc with a 60-db dynamic range centered at an antenna temperature of 10^6°K. The incorporation of a novel thermistor-bridge power meter yields a long-term measurement accuracy of ±1/2 db. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N68-27012# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
GREASES—A METHOD FOR DETERMINING HIGH SHEAR STABILITY
Robert L. Young Mar. 1968 24 p refs
(RIA-68-654; AD-668660)

Equipment was designed and built for the very high shear working of grease. The mechanical stability of eight greases was determined using the very high shear equipment. Breakdown of the greases was evaluated by consistency as determined in the 1/4 scale worked penetration, ASTM Test Method D-1403. Results are given in tables and graphs comparing the mechanical stability of seven lubricating greases and the effect of four shear rates. Details are given for the construction of the very high shear equipment. Author (TAB)

N68-27054# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
ON CONFIDENCE LIMITS FOR THE PERFORMANCE OF A SYSTEM WHEN FEW FAILURES ARE ENCOUNTERED
Sam C. Saunders Nov. 1967 43 p refs *Its* Mathematical Note No. 540
(D1-82-0676; AD-668983)

In some situations encountered today the components are so reliable that no failures are observed within the time available for testing. This can pose a problem in data analysis and interpretation. Consideration is given to the problem of determining lower confidence bounds on the reliability of a complex system, such as the Saturn 1-C, when each component is assumed to have an exponential life and different components have different multiplicities within the system. We discuss and compare the confidence limits obtainable from various interpretations of the data and several theories such as asymptotic likelihood ratio, asymptotic maximum likelihood, the Bayesian method and the new method presented here utilizing the conditional probabilities of malfunction of the components given that a malfunction in the system has occurred. Author (TAB)

N68-27113# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AVIATION ANTI-FRICTION BEARINGS
R. V. Korostashevskiy and A. M. Zaytsev 29 Aug. 1967 342 p refs Transl. into ENGLISH of the book "Aviatsionnyye Podshipniki Kacheniya" Moscow, Gos. Nauchno-Tekhn. Izd. Oborongiz, 1963 p 1–340
(FTD-65-372; AD-668520)

The authors generalize on experience in the design and operation of roller-contact bearings used in aircraft structures. Designs and basic characteristics of bearings, methods for their lubrication and cooling, and various factors effecting the efficiency of bearings are analyzed, as well as designs of individual units with bearings. Methods of calculation of bearings are given; the recommended methods for investigation of typical defects and fractures, as well as the order of damage detection in overhauling are described. The necessary reference data on bearings and various instructional data are given. Author (TAB)

N68-27230*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PIVOTED-PAD JOURNAL GAS BEARING PERFORMANCE IN EXPLORATORY OPERATION OF BRAYTON CYCLE TURBOCOMPRESSOR

Robert Y. Wong, Warner L. Stewart, and Harold E. Rohlik [1968] 29 p refs Presented at the 2nd Intern. Symp. on Gas Lubrication Design Appl. and Exhibit, Las Vegas, Nev., 10–17 Jun. 1968; Sponsored by the Lubrication and Nucl. Div. of the Am. Soc. of Mech. Engr. and ONR

(NASA-TM-X-52372) CFSTI: HC$3.00/MF$0.65 CSCL 13I

Findings obtained to date in the area of journal gas bearings from an experimental study of a Brayton Cycle turbocompressor designed for the requirements of a two-shaft–10-kilowatt space power system were described. The journal bearing design utilizes three pads pivoted on conforming balls and sockets. Two of the pivots are rigidly mounted to the frame, and the third pivot is mounted to the frame through a low-spring-rate diaphragm. The paper describes the salient package and bearing design features and then presents the principal results obtained from testing the package in both a spin calibration rig and operation at design temperature conditions with an inert gas. The results discussed include (a) the successful use of a pneumatic loading device to vary pad load during operation, (b) the operating characteristics of the bearings as obtained over a range of pad loads and ambient conditions, (c) structural and dynamic behavior of the bearing-support system during design temperature operation, and (d) a discussion of the wear characteristics of the conforming ball and socket pivot as obtained from the tests made to date. Author

N68-27330# Naval Missile Center, Point Mugu, Calif.

RELIABILITY AND CONFIDENCE LIMITS FOR SAMPLE TESTING: BASED ON THE BINOMIAL DISTRIBUTION GRAPHS FOR SAMPLE SIZES FROM 1 TO 100, AND FROM 100 TO 1,000 IN MULTIPLES OF 10

C. J. Thorne and R. W. Claassen 29 Apr. 1968 207 p refs

(NMC-MP-68-2; AD-668984)

Graphs are given for the determination of the upper and lower reliability confidence limits as defined by the number of successes in a random sample test. The graphs are for sample sizes from 1 to 100, and also from 100 to 1,000 in multiples of 10, and any number of successes. Two reliability results can be read directly from the graphs: the probability confidence that the reliability is at least p sub l, and that it is at most P sub u. The number of successes required for a particular sample to meet stated reliability confidence levels can be read. The graphs can also be used in determining whether the sample falls within predetermined risk levels. Author (TAB)

N68-27331*# SKF Industries, Inc., King of Prussia, Pa. Engineering and Research Center.

SUPERSONIC TRANSPORT LUBRICATION SYSTEM INVESTIGATION, PHASE 1 Final Summary Report, 28 Oct. 1964–2 Jul. 1967

W. L. Rhoads and L. B. Sibley 18 Sep. 1967 219 p refs

(Contract NAS3-6267)

(NASA-CR-54662; AL67T060) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Ball bearings and bellows face seals for use on Mach 3 aircraft gas turbine engine mainshafts have been tested in this program with several selected lubricants using both oil-mist and recirculating jet lubrication systems, with provisions for inert gas blanketing. Bearing operating temperatures of 600°F to 800°F have been explored under typical engine load and speed conditions with the seals exposed to 1200°F air and a pressure differential of 100 psi. Using a conventional aircraft engine recirculating lubrication system and M-50 or WB49 tool steel ball bearings of current design, with the most promising fluid lubricants available, it was possible to obtain satisfactory short term (3–10 hrs.) bearing operation at temperatures of 700 to 750°F. Oil seals have proven to be troublesome at the temperatures and speeds tested, but satisfactory air seal operation has been realized. The mist system has shown tendencies of thermal unstability but otherwise ran successfully at 600°F. Author

N68-27332*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.

DETERMINATION OF OPTIMUM FABRICATION TECHNIQUES FOR THE PRODUCTION OF AUSTENITIC REFRACTORY BIMETALLIC TUBING Midpoint Report, 29 Mar.–23 Oct. 1967

R. W. Buckman and J. N. Kass 23 Oct. 1967 41 p refs

(Contract NAS3-10601)

(NASA-CR-72394; WANL-PR-(ZZ)-003) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The purpose of this investigation is to evaluate and characterize three lots of refractory (tantalum)/austenitic (Type 316SS) bimetal tubing using both destructive and non-destructive testing. Tantalum, 0.020 inch thick comprises the inner liner of the tube which is clad with 0.080 inch thick type 316SS. After evaluation, a portion of the tubing will be used to fabricate a prototype tube-in-tube boiler for the SNAP-8 system. Both columbium and tantalum exhibit very excellent corrosion resistance to mercury and the austenitic stainless steel is resistant to NaK under the environmental conditions predicted for the SNAP-8 boiler. The Ta-316SS combination was selected as the optimum combination based in part on prior work. The bimetal tubing to be evaluated was furnished by NASA and consisted of three lots of tubing. Author

N68-27358 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

HEAT EXCHANGE IN EXTRUSION CASTING

6 Jun. 1967 102 p refs Transl. into ENGLISH of the book "Teploobmen Pri Lit'ye Vyzhimaniyem", Moscow, Oborongiz, 1963 p 1–100

(FDT-MT-64-257; AD-668233)

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4. THERMOPHYSICAL PROPERTIES OF MATERIALS M. N. Galkin, T. G. Tarasutin, and I. L. Pushkin p 73–80 refs (See N68-27362 16-15)

N68-27359 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXTRUSION CASTING OF THIN-WALLED PARTS [LIT'YE TONKOSTENNYKH DETALEY VYZHIMANIYEM]

M. N. Galkin and E. S. Stebakov *In its* Heat Exchange in Extrusion Casting 6 Jun. 1967 p 3–16 refs (See N68-27358 16-15)

The authors analyze the process of filling stationary casting molds and discuss press casting mechanisms for an angular or plane-parallel return of the matrix from one or both sides. A description is given of a currently operational unit. The unit's weight is 9500 kg net; it is 3240 mm long, 2850 mm wide and 1500 mm high. Maximum lid return pressure is 6800 kg. The unit is operated by two men and can produce 4 to 6 casts per hour (up to 2100 mm long, 1200 mm high and 1 mm or more in thickness). Preparation of the unit and the operating procedure are described. Tolerances are held to ± 0.5 mm on panel face across a length of 200 mm, ± 0.3 mm for thickness of wall and ribs and ±1 mm for linear dimensions and diameters of lugs. The microvariance of the face surface does not exceed 0.04 mm. Average elongation of the cast panels was 3%; tensile strength 22 kg/mm^2. Author

N68-27360 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMAL CALCULATION OF THE CRUCIBLE [TEPLOVOY RASCHET METALLOPRIYEMNIKA]

M. N. Galkin and L. L. Govseyev *In its* Heat Exchange in Extrusion Casting 6 Jun. 1967 p 17–40 refs (See N68-27358 16-15)

The paper deals with the results of experimental and mathematical studies on the cooling of the alloy during pouring, the temperature field in the alloy prior to extrusion from the crucible, and the profile of the solid alloy crust formed on the walls. Two harmonious solutions are derived which permit calculation of the tridimensional temperature field in the alloy during cooling in the ladle and metal conduits, the time of onset of hardening in the crucible, and the amount of crust at any point on the crucible wall. Calculations show that the temperature of the alloy in the crucible drops by 44°C during casting, producing a longitudinal temperature gradient of as much as 58°C. During the next 50 seconds, the average temperature drops by 80°C, while the temperature gradient remains unchanged for 33 seconds and then drops to 15°C during the last 17 seconds. A hard alloy crust, 2 mm thick, is formed at the ends of the crucible, and the vertical temperature gradient at the center before extrusion can reach 45°C. Comparison of the theoretical results with experimental data indicates that this approach permits calculation of the optimal temperature field in the alloy prior to extrusion and application of the appropriate corrections in the selection of machine design and thermal parameters. Author

N68-27361 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORY OF EXTRUDING AN ALLOY AND FORMING A PANEL [TEORIYA VYZHIMANIYA SPLAVA I FORMIROVANIYA PANELI]

M. N. Galkin *In its* Heat Exchange in Extrusion Casting 6 Jun. 1967 p 41–71 refs (See N68-27358 16-15)

The author describes the mathematical theory of alloy squeeze casting and panel formation in squeeze-casting machines with a plane-parallel and angular (unilateral or bilateral) approach of the dies; panel formation on the machine is taken as an example. The theoretical calculations show that it is possible to select the hydrodynamic conditions of alloy extrusion so as to obtain specified relationships between time and the duration, speed and acceleration of alloy motion. The alloy cooling and hardening processes during and after extrusion may be calculated both for the central part and for ribs, nodes, etc. It has been shown that the procedures selected for the machine are close to optimal. However, some improvement in the quality and stability of the castings may be attained by decelerating alloy extrusion in the deadhead so that 40–60% more of the alloy will harden in the working part of the mold. Author

N68-27362 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMOPHYSICAL PROPERTIES OF MATERIALS [TEPLOFIZICHESKIYE SBOYSTVA MATERIALOV]

M. N. Galkin, T. G. Tarasutin, and I. L. Pushkin *In its* Heat Exchange in Extrusion Casting 6 Jun. 1967 p 73–90 refs (See N68-27358 16-15)

Assuming that the core material is homogeneous, the authors present a simple experimental technique for determining the principal thermophysical constants of cores and mold washes, as well as the heat capacity and latent heat of solidification of alloys. By the method of pouring metal into molds, the authors derive a relationship between the principal parameters of a and b cores, prepared from wet sand, self-hardening and quick-drying materials, and their density and moisture content of the concentration of binder. The experimental data are shown in the form of nomograms which permit rapid selection of the appropriate coefficients. In the same way, the authors investigated the thermal conductivity of various washes and the relationship between this value and the number of casting operations. It was found that the thermal conductivity increases with the number of castings, rising particularly sharply after the first one. This increase in thermal conductivity is the result of both an increase in heat conduction and a decrease in thickness. This technique for the experimental determination of the true and average heat capacity and latent heat of solidification simplifies practical tests and increases their accuracy. Author

N68-27379# American Meteorological Society, Boston, Mass.

STUDY OF THE OPERATIONS IN SAWING OF SYNTHETIC RUBY CRYSTALS AS A FUNCTION OF CRYSTALLOGRAPHIC ORIENTATION

S. I. Gavrishchuk *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 253–262 ref (See N68-27363 16-18)

To minimize waste in the processing operation, experiments were conducted to determine which angle to the optic axis of the crystal is best for sawing the half-boules into half-moons. Crystals sawed into half-moons parallel to the optic axis had a smooth surface without hackles or chips; crystals sawed perpendicular to the optic axis always resulted in chipping of the edges of the half-moons, and in rough surfaces with chips and hackles. Experiments were also conducted to determine which crystallographic orientations of the boules are most favorable for sawing ruby crystals into blanks. The data show that the highest yield of suitable square blanks per kilogram of ruby was obtained for crystals with an angle of 56° to 57° between the geometric and optic axes of the boules. It is also reported that with the present technology of manufacturing watch jewels, under which the half-boule is sawed perpendicular to its geometric axis, the lowest percentage of scrap is produced in sawing half-boules with an angle of 57° between the geometric and optic axes. M.G.J.

N68-27380# American Meteorological Society, Boston, Mass.

INFLUENCE OF CRYSTALLOGRAPHIC ORIENTATION ON RUBY WORKABILITY

M. G. Bogdanovich *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 263–272 (See N68-27363 16-18)

Experimental data are presented on the low resistance of ruby to parting along planes parallel to prismatic faces, and on the tendency of ruby slabs to split parallel to the trace of the parting plane of the half-boule. Also considered is ruby processing quality and surface grinding suitability as a function of optic axis position. It was found that the best quality of grinding is achieved on surfaces parallel to the parting plane of the ruby half-boule, and that planes parallel to the optic axis are the most suitable for processing. M.G.J.

N68-27414*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

LUBRICATION AND BEARING PROBLEMS IN THE VACUUM OF SPACE

Edmond E. Bisson [1966] 32 p refs Presented at the Symp. on Friction Days Sponsored by GAMI, Paris, 5–6 Dec. 1966
(NASA-TM-X-59570) CFSTI: HC$3.00/MF$0.65 CSCL 13I

Various problems involving the operation of spacecraft mechanisms, their relative importance, and some indication of research in these various areas are summarized. These problems include exposure to certain peculiarities of space such as (1) a very low ambient pressure, (2) a radiation environment, (3) the absence of gravitational field, and (4) the presence of atomic species other than the normally encountered molecular species. The simulation of these various conditions in a vacuum chamber is discussed, and the requirements to conduct meaningful experiments in a vacuum are delineated. A Langmuir equation is given for determining the evaporation rate of lubricant in a vacuum, and evaporation rates were determined for various oils and greases, metals, inorganic coatings, and polymers. Results are given on friction and wear experiments conducted in air and vacuum with five alloy combinations in the unlubricated state. The marked differences in friction and wear between metals of cubic and hexagonal crystal structures are delineated. An assessment is made of solid-film lubricants and gallium coatings, and lubrication used for rolling-element bearings on the Tiros 2 satellite is evaluated. B.S.D.

N68-27461*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

VACUUM HOT PRESSING OF MAGNESIUM ALUMINATE

Donald R. Rummler [1967] 41 p refs Presented at the Am. Ceram. Soc., Basic Sci. Div. Meeting, University Park, Penn., 9–11 Oct. 1966

(NASA-TM-X-59053) CFSTI: HC$3.00/MF$0.65 CSCL 13H

The purposes of this investigation were to examine the applicability of a phenomenological rate equation for hot-pressing and characterize the densification behavior of magnesium aluminate during hot-pressing. In order to accomplish these objectives, the densification kinetics of magnesium aluminate powder compacts during vacuum hot-pressing were studied between 1175° and 1460°C and from 500 to 5100 psi. The proposed rate equation, which treats porosity as a functionally independent variable, is analogous to several relationships which have been proposed for unconstrained creep. It is shown that the treatment of porosity as an independent variable is reasonable and does not functionally restrict porosity as a modifier of the applied stress. The rate equation, which suggests a logarithmic relationship between strain rate and porosity, provided an excellent description of the observed densification. The strain rate dependence on porosity was found to decrease at a porosity of approximately 0.15. The observed change in porosity dependence was not strongly influenced by stress or temperature. Author

N68-27528*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EVALUATION OF LUBRICANTS FOR HIGH TEMPERATURE BALL BEARING APPLICATIONS

Richard J. Parker, Eric N. Bamberger, and Erwin V. Zaretsky Washington 1967 28 p refs Presented at the Lubrication Conf. Sponsored by the Am. Soc. of Lubrication Engr. and ASME, Chicago, 17–19 Oct. 1967

(NASA-TM-X-52321) CFSTI: HC$3.00/MF$0.65 CSCL 11H

Several lubricants that are considered candidates for ball bearing applications in the temperature range of 500° to 700°F were investigated in fullscale ball bearings and in a rolling-contact fatigue rig. Bearing endurance tests indicate that a synthetic paraffinic oil with an anti-wear additive can perform beyond catalog rating at temperatures up to 600°F in a low oxygen environment. In a rolling-contact fatigue tester, this synthetic paraffinic oil exhibited at least twice the fatigue life at the 10-percent level of a fluorocarbon and a polyphenyl ether. Based on bearing race goorve appearance, elastohydrodynamic lubrication was apparent at outer race temperatures up to 700°F. Author

N68-27529*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CONVECTIVE INERTIA AND GAS INGESTION EFFECTS ON FLOW REGIMES OF THE VISCOSEAL—THEORY AND EXPERIMENT

John Zuk, T. N. Strom, L. P. Ludwig, and R. L. Johnson [1967] 60 p refs Presented at the Am. Soc. of Lubrication Engr. Ann. Meeting, Toronto, 1–4 May 1967

(NASA-TM-X-59831) CFSTI: HC$3.00/MF$0.65 CSCL 11A

An experimental and visual investigation of the viscoseal operating regions was conducted. A mathematical model was formulated for the homogeneous fluid region which resulted in an evolution of a modified Reynolds' number based on two characteristic lengths. Importance of convective inertia forces and changes in the function relations between variables in the super laminar flow regime are discussed. Correlation between modified Reynolds number and sealing capacity improvement is found. Experimental studies using oil, water, and liquid sodium were conducted on pressure patterns, end effect, gas ingestion, and sealing capacity. Studies reveal a fundamental difference in the gas ingestion mechanism between grooves on the shaft and grooves on the housing. Gas ingestion could be eliminated in the grooved housing operational mode. Secondary grooves on the viscoseal land areas improved sealing capacity. Sodium was sealed at 300 to 625°F with negligible liquid loss. Author

N68-27569*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STUDIES OF ROLLING ELEMENT LUBRICATION AND FATIGUE LIFE IN A REDUCED PRESSURE ENVIRONMENT

David W. Reichard, Richard J. Parker, and Erwin V. Zaretsky [1967] 18 p refs Presented at the Ann. Meeting of the Am. Soc. of Lubrication Engr., Toronto, Can., 1–4 May 1967

(NASA-TM-X-52287) CFSTI: HC$3.00/MF$0.65 CSCL 13I

Fatigue tests were conducted in a modified five-ball fatigue tester on SAE 52100 steel ball specimens, at atmospheric pressure and at the approximate lubricant vapor pressure with two different lubrication methods, using a super-refined naphthenic mineral oil as the lubricant. Additional tests were conducted with AISI M-50 ball specimens with polyphenyl ether lubricants. Differences in fatigue life, deformation and wear with the mineral oil lubricant were insignificant regardless of the ambient pressure environment or lubrication method employed. Polyphenyl ether lubricants exhibited large amounts of wear both at atmospheric and reduced pressures indicating a lack of an elastohydrodynamic film with this lubricant under the stresses and sliding velocities present in the five-ball fatigue tester. Author

N68-27725# System Development Corp., Santa Monica, Calif.

STUDY OF NONPARAMETRIC TECHNIQUES FOR ESTIMATING RELIABILITY AND OTHER LIFE QUALITY PARAMETERS Final Technical Report

V. K. Murthy 20 Feb. 1968 114 p refs Prepared for McDonnell-Douglas Co., Santa Monica, Calif.

This study was undertaken to carry out a comprehensive investigation of procedures for estimating probability distributions of life lengths, as well as the corresponding probability densities and hazard functions, in situations where little or no information is available on the family of the underlying failure laws. In carrying out this study, nonparametric techniques were developed for obtaining estimates and confidence bands for various kinds of samples of life lengths—i.e., for random, censored, and truncated samples. Large-sample techniques of this kind are derived and discussed and a procedure for optimizing the methods of estimation is recounted. Discontinuities of the life distribution function correspond to times at which the devices considered are exposed to increased "instantaneous hostility." A statistical test is proposed which makes it possible to determine whether such moments of increased instantaneous hostility are present. Author

N68-27862# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A METHOD OF APPRAISING THE THERMOOXIDIZING STABILITY OF AVIATION OILS AT RAISED TEMPERATURES [METOD OTSENKI TERMOOKISLITEL'NOY STABIL'NOSTI AVIATSIONNYKH MASEL PRI POVYSHENNYKH TEMPERATURAKH]

L. V. Starikova, G. S. Bleyes, and Ye. T. Kruglov *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 99–103 ref (See N68-27850 16-27)

A laboratory method for evaluating the performance properties of petroleum oils at elevated temperatures was developed and examined. The method is an adaptation of VTI GOST 981-55, wherein conditions for oxidizing the oil were changed to make the test applicable to high temperature testing. Oxidations were run in the apparatus shown under temperatures controlled by thermostat. Determinations were made of volatility, change in viscosity, benzene-insoluble residues, acid number and metal corrosion as indices of resistance of the oil to thermal oxidation. Satisfactory reproducibility among the values of these indices was obtained in the tests run. Author

N68-27863# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DETERMINING THERMAL STABILITY OF LUBRICATING GREASES [OPREDELENIYE TERMICHESKOY STABIL'NOSTI KONSISTENTNYKH SMAZOK]

A. R. Kosyakin and Ye. A. Uspenskaya *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 105–110 (See N68-27850 16-27)

The new method worked out for determining the thermal stability of lubricating greases is based on determining the length of time the grease is heated at a given temperature to complete dryness, and the effect of atmospheric oxygen on it. The proposed method was found sufficiently accurate for temperatures of 120–350°C. The method clearly shows the effect of temperature on thermal stability of different greases and helps to differentiate between greases of different compositions according to their thermal stability. It was established that volatility alone cannot be used as a characteristic of thermal stability of greases since factors such as chemical oxidation, thermal decomposition and polymerization affect their drying rate. Author

N68-27864# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METHOD OF APPRAISING THE LUBRICATING ABILITY OF HIGH TEMPERATURE LUBRICANTS IN A WIDE RANGE OF TEMPERATURES [METOD OTSENKI SMAZOCHNOY SPOSOBNOSTI VYSOKITEMPERATURNYKH SMAZOK V SHIROKOM DIAPAZONE TEMPERATUR]

L. A. Mayorova *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 111–117 refs (See N68-27850 16-27)

The author describes several methods for evaluating the lubrication capacity of high-temperature lubricants. An up-to-date four-sphere unit with a tetrahedral arrangement is used to estimate the lubrication capacity of high-temperature lubricants. Lubricating capacity is estimated with respect to the average diameter of sphere wear spots as a function of load, temperature, sliding wear and critical load. An expression is given for calculating the sliding rate. The standard test lasts one minute. The load is increased stepwise during testing and the wear spots on the three lower spheres are measured after each load setting. Two high-temperature lubricants were tested with melting points of 390 and 150°C. The results show that the proposed method may be used for evaluating lubrication capacity within ±10%. The maximum diameter of wear spots is observed at 300°C. In comparing the two specimens tested, it was found that the lubrication capacity of the second (melting point 150°C) is much better than that of the first from −60 to +500°C. A table is given showing the effect of load on the lubrication capacity of high-temperature lubricants at −40 and +500°C. Author

N68-27865# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

APPRAISING THE EFFICIENCY OF GREASE LUBRICANTS IN BALL BEARINGS [OTSENKA RABOTOSPOSOBNOSTI KONSISTENTNYKH SMAZOK V SHARIKOVYKH PODSHIPNIKAKH]

A. R. Kosyakin, Ye. A. Uspenskaya, and Yu. V. Iskusnykh *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 119–126 refs (See N68-27850 16-27)

Experimental data are given on a new method for comparative evaluation of the work capacity of greases used in high-speed closed roller bearings operating at temperatures below 350°C. Duration of normal bearing operation is used as the criterion for evaluating the work capacity of the lubricants. The point of binding is assumed as the breakdown point of normal bearing operation. Binding is characterized by disruption of smooth bearing operation and by a significant temperature increase in the external ring. 1.5 and 3 g of lubricant were used throughout the tests for each bearing. The bearings were tested at 5,000 and 10,000 rpm and 200 and 350°C with a radial load from 50 to 450 kg. The tests were arranged in five-hour sequences. The results show that the nominal work capacity of TsIATIM-221 grease is 13 hours, while that for VNII NP-222-2 lubricant is 1 hour at 500 rpm, 250°C bearing temperature and a radial load of 250 kg. VNII NP-222-2 and VNII NP-206 lubricants showed a similar work capacity under identical conditions. Author

N68-27866# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METHODS OF DETERMINING THE TEMPERATURE OF SELF IGNITION OF OILS [METODY OPREDELENIYA TEMPERATURY SAMOVOSPLAMENENIYA MASEL]

G. I. Yudina and V. N. Khaylova *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 127–131 refs (See N68-27850 16-27)

The authors discuss the results of a comparative study of three general methods used for determining the autoignition temperatures of aviation oil. The three methods studied are the Yench method, the "drop" method and a method developed by the Scientific Research Institute of the Civil Air Fleet. The Yench method is characterized by the fact that autoignition temperature is determined at a constant oil-to-oil ratio without the necessity for considering oil type. The "drop" method is characterized by the fact that the quantity of oil has to be considered before the experiment. This is done by starting with an oil–air mixture with the lowest autoignition temperature for the given oil. The apparatus of the Scientific Research Institute of the Civil Air Fleet consists of a plate made from stainless refractory steel 3–4 mm thick located on an electric plate and covered by a double jacket. The air space within the double jacket acts as insulation. This method provides simultaneous measurements of the gas phase temperature at a given distance from the plate by using a thermometer, and the metal plate temperature by using a thermocouple. A comparison of the methods shows that the "drop" method is by far the most accurate. Author

N68-27884 California Univ., Davis.

MELT LUBRICATION OF AN ANNULAR THRUST SURFACE

Charles William Allen (Ph.D. Thesis) 1966 134 p

Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8862

The quasi-steady state melt lubrication of an annular thrust surface with axial symmetry and one dimensional heat flow in the axial direction is investigated analytically and experimentally. An analytical solution is obtained by assuming that the molten material forms a continuous molten layer which completely separates the solid surfaces. The theoretical analysis shows that complete separation of the solid surfaces is possible, and this results in a theoretical coefficient of friction which decreases with load and may reach values of 0.01 or less. The experimental part of the investigation was performed by using an annular steel slider sliding on a Cerrobend specimen. The results of the experimental investigation did not confirm the theory. The coefficient of friction obtained was higher than predicted and showed that solid to solid contact was probably occurring throughout the test. On the basis of the experimental evidence, a new interfacial model is proposed in which there are islands of solid projecting through the main interfacial film of molten material. On the top of each peak there exists a thin molten film which itself is broken by microscopic asperities. These asperities provide the solid to solid contact with similar asperities on the slider. The significant viscous shear stress arises principally in the region close to the top of each peak rather than in the main body of the molten film. Dissert. Abstr.

N68-27900*# Chrysler Corp., New Orleans, La. Space Div.
DUAL BALL SHUTOFF VALVE, 1/2-INCH, 1500 PSIG, CAM OPERATED, FLODYNE CONTROLS INC. PART NUMBER 5C151, NASA DRAWING NUMBER 75K26264
Tom W. Sparks 10 Apr. 1968 90 p
(Contract NAS8-4016)
(NASA-CR-95251; TR-RE-CCSD-FO-1139-3) CFSTI: HC $3.00/MF $0.65 CSCL 13K

The results of test performed on three specimens of the cam operated dual shutoff valve are presented. The following tests were performed: receiving inspection, proof pressure, functional, low temperature, high temperature, vibration, salt fog, life cycle, repeatability, shaft travel and ball rotation, flow, and burst. The three cam operated dual ball shutoff valves met the requirements throughout the test program. Author

N68-27901*# Chrysler Corp., New Orleans, La. Space Div.
PRESSURE REGULATOR, 1-1/2 INCH, ACCESSORY PRODUCTS COMPANY PART NUMBERS 140200-11 AND 140200-14, NASA DRAWING NUMBERS 75M04839-1 AND 75M04839-4 Test Report
15 May 1968 133 p
(Contract NAS8-4016)
(NASA-CR-95224; TR-RE-CCSD-FO-1030-3) CFSTI: HC $3.00/MF $0.65 CSCL 13K

This report presents the results of tests performed on two samples each of pressure regulators. The regulators are different only in orifice size. The 75M04839-1 has a 3/8-inch orifice and the 75M04839-4 has a 1-inch orifice. The following tests were performed: receiving inspection, proof pressure, functional, prolonged pressure, low temperature, high temperature, surge, vibration, salt fog, flow & regulator setting, life cycle, and burst. The performance of the specimens was generally in accordance with the requirements. Author

N68-27902*# Air Reduction Co., Inc., Murray Hill, N. J. Research and Engineering Dept.
SATURN MANUFACTURING TECHNOLOGY FOR WELDING METHODS AND TECHNIQUES Final Report, Jun. 1966–Jun. 1967
E. H. Cushman 29 Jun. 1967 156 p
(Contract NAS8-20338)
(NASA-CR-61843; RE-67-084-CRE-42) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The purpose of this program was to assess the relative merits of new types of power supplies for gas tungsten-arc welding of 2014-T6 aluminum. In the first phase of the program, exploratory tests were made to determine the welding conditions required of each power supply to achieve full penetration welds in 1/4 in. plate and to determine their soundness and properties. The second phase involved an evaluation of the influence and interaction of the welding parameters on weld shape and properties for each of the power supplies. Finally, fully penetrated welds were made with each power supply adjusted for its best mode of operation, and the welds were compared with others made with conventional a–c and d–c power supplies. In the final comparison none of the new power supplies was found to have a significant advantage over the conventional power supplies. Using the optimum conditions of welding, the conventional direct-current welds produced the highest average yield and tensile strengths of all the welds tested. Author

N68-28031# Mechanical Technology, Inc., Latham, N. Y.
DESIGN OF LIQUID METAL LUBRICATED BEARINGS. VOLUME 2: AN EXPERIMENTAL INVESTIGATION OF NaK LUBRICATED TILTING AND BEARINGS Final Report
W. D. Waldron and E. B. Arwas 28 Feb. 1968 136 p refs
(Contract AT(30-1)-3363)
(NYO-3363-7, V. 2; MTI-68TR7, V. 2) CFSTI: HC $3.00/MF $0.65

An experimental investigation was conducted to assess the validity of liquid metal-lubricated bearing design data. Sodium–potassium eutectic was used as the lubricant. Tests were run at 110 to 120°F. The design, selection, and testing of the test rig and sodium–potassium loop are described in detail. The operation of the actual test program, the data generated and its comparison with theory are given. In general, the design data was found to correlate well with the experimental results. Due to the need for special instrumentation for components in reactor sodium systems, calibration tests were performed for a high temperature, inductive type proximity transducer, first at the low ambient test temperatures and then at 500, 700, and 1000°F. Further development is recommended to improve the reliability of this instrumentation in high temperature bearing tests. NSA

N68-28077# Mechanical Technology, Inc., Latham, N. Y.
DESIGN OF LIQUID METAL LUBRICATED BEARINGS. VOLUME 1: DESIGN DATA FOR TILTING PAD BEARINGS IN THE LAMINAR AND TURBULENT FLOW REGIMES Final Report
E. B. Arwas and W. D. Waldron Feb. 1968 226 p refs
(Contract AT(30-1)-3363)
(NYO-3363-7, V. 1; MTI-68TR6, V. 1) CFSTI: HC $3.00/MF $0.65

A 3 1/2 year program was undertaken to study liquid metal lubricated bearings which are particularly important for nuclear powered turbogenerators that use liquid metals as the cycle fluids. Current work on the preparation of detailed design data for such bearings is reported. A comprehensive set of design data is included that covers operation of tilting-pad journal bearings in both the laminar and the turbulent flow regimes. In this design all fluid-dynamic bearing characteristics are tabulated as functions of bearing geometry and operating conditions. The data are presented in normalized form so that it is applicable (within the specified limits on operating conditions) for all bearing sizes and clearance ratios. It covers the full range of generally used bearings, ranging from 3 to 6 pads per bearing, with length-to-diameter ratios from 0.25 to 1 for Reynolds Numbers up to 30,000. The improvements in bearing performance achievable by preloading the bearings for certain conditions of operation are stressed and the design data given covers the range of preload from 0 to 0.5. NSA

N68-28091*# Chrysler Corp., New Orleans, La. Space Div.
GLOBE VALVE, 3/4-INCH, 6000 PSIG, PACIFIC VALVE CO. PART NUMBER 3/4-S-17250Y-12K-GL(XXS), NASA DRAWING NUMBER 75M09618 PGLV-3 Test Report
9 May 1968 102 p
(Contract NAS8-4016)
(NASA-CR-95266; TR-RE-CCSD-FO-1117-3) CFSTI: $3.00 CSCL 13K

Test results are reported for a 3/4-inch, 6000 psig, globe valve that is rated as a shutoff valve for venting high pressure GH_2 storage bottles. During the functional test leakage was observed around the valve stem when the inlet port of the specimen was pressurized to 100 psig, but this leakage stopped when the housing eye bolts were tightened to the recommended torque. During cycle 562 the valve would not seat regardless of the amount of torque applied, and disassembly revealed a badly eroded KEL-F seat. The valve failed at 22,500 psig during burst testing, which was short of the 24,000 psig minimum burst pressure set by the specification. Water leakage occurred at the bonnet gasket during the burst test at 22,500 psig. Proof pressure, temperature, and environmental tests were satisfactory; and the valve is considered qualified for a cross country 6000 psig shutoff device that is suitable for monodirectional flow over the plug. It is not capable of fine metering because of plug design. M.W.R.

N68-28105# Sandia Corp., Albuquerque, N. Mex.
PACKAGING THREE-DIMENSIONAL OBJECTS USING GRADIENT TECHNIQUES
C. L. Bisson Dec. 1967 74 p refs Prepared by Thomas Bede Found., Los Altos, Calif.
(SC-CR-67-2863) CFSTI: HC$3.00/MF$0.65

A technique is presented for placement of three dimensional objects within a surface of revolution and at the same time optimizing the following properties: 1. The objects shall fit as closely as possible. 2. Locate the center of gravity of the objects as close as possible to a specified point. 3. Minimize the error in dynamic and static balance. 4. Allow objects to be maintained at least a certain minimum distance apart. 5. Allow any of three degrees of translation or rotation to be fixed. The above are achieved by enclosing each object with one or several spheres and defining potential functions between the spheres. The potential functions and the above functions are optimized using gradient techniques. An example with ten objects is presented. Author (NSA)

N68-28125# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
LIQUID METAL MEASURING AND LOADING STATION
J. A. Yount and L. E. Chulos Mar. 1968 14 p
(Contract AT(45-1)-1830)
(BNWL-705) CFSTI: HC$3.00/MF$0.65

An economical device for the accurate measurement and dispensing of small volumes (30 to 500 ml) of liquid metal is described. Preliminary oxygen analysis shows the system contamination to be less than 33 ppM with a 20 ppM oxygen supply. This level of contamination is expected to diminish with operation. Author (NSA)

N68-28139# California Univ., Livermore. Lawrence Radiation Lab.
COMPLEX SHEAR MODULUS OF A HIGH EXPLOSIVE
Marvin A. Hamstad 24 Oct. 1967 22 p refs
(Contract W-7405-ENG-48)
(UCRL-50357) CFSTI: HC$3.00/MF$0.65

A machine was designed to subject a right circular, cylindrical, viscoelastic specimen to forced, sinusoidal, torsional oscillation. The ends of the specimen are bonded to rigid boundaries, one of which is fixed, while the other is subjected to a sinusoidal torque. Measurement of the amplitude ratio of essentially the torque to the twist and the phase angle between these two quantities allows determination of the complex shear modulus of an assumed isotropic, homogeneous, linear, viscoelastic material. The complex shear modulus is obtained over a wide range of frequency (0.0004 to 1.0 cps) and temperature (−15 to 125°F) as well as at different levels of shear strain. The material tested is a high explosive known as LX-04-1. Assuming this material behaves as a thermorheologically simple solid, use of time-temperature shifting principle allowed an extension of the time scale to 13 decades. This assumption also allows construction of the so-called master (or composite) curves for the storage and loss moduli. Author (NSA)

N68-28241*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OPERATION OF A LIQUID FLUORINE PUMP IN CAVITATING FLOW AT AN INDUCER TIP SPEED OF 188 FEET PER SECOND (57.3 M/SEC)
Walter M. Osborn Washington Jun. 1968 15 p refs
(NASA-TM-X-1573) CFSTI: HC$3.00/MF$0.65 CSCL 13K

A combination cavitating inducer and main-stage impeller was operated in liquid fluorine for 36 minutes. The inducer tip relative flow velocity was approximately 188 feet per second. Both noncavitating and cavitating pump performance are presented. For approximately 18 minutes the inducer was operating with moderate to heavy cavitation. No cavitation damage was experienced. Titanium carbide cermet with nickel binder and aluminum oxide performed adequately as seal materials. Author

N68-28249*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE USE OF THE ELECTRON PROBE MICROANALYZER IN MATERIALS RESEARCH AND DEVELOPMENT
Lawrence Kobren Washington Jun. 1968 25 p refs
(NASA-TN-D-4526) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The electron probe microanalyzer, a versatile tool for the analysis of areas as small as one micron in diameter, has been used at Goddard Space Flight Center in applications ranging from materials research to analysis of failures in mechanical parts. Methods of using the probe and representative results obtained are illustrated by several examples that include bonding of thermoelectric materials, alloy development, and analysis of materials failures. Author

N68-28258*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF BALL-RACE CONFORMITY ON SPINNING FRICTION
Marshall W. Dietrich, Richard J. Parker, and Erwin V. Zaretsky Washington Jul. 1968 19 p refs
(NASA-TN-D-4669) CFSTI: HC$3.00/MF$0.65 CSCL 13I

Tests were conducted in the NASA spinning friction apparatus with SAE 52100 steel specimens with ball-groove conformities of infinity (ball on a flat), 60, 55, and 51 percent. The coefficient of spinning friction decreased with increasing maximum Hertz stress to a minimum value of approximately 0.05. For a constant stress, the coefficient of spinning friction increased with decreasing conformity (increasing percent conformity). Spinning torque increased with increasing stress for each conformity tested. For a given stress, spinning torque decreased with decreasing conformity. Author

N68-28260*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF CRYSTAL TRANSFORMATION AND ATOMIC ORDERING ON FRICTION AND WEAR OF TWO COBALT-BASE ALLOYS IN VACUUM

William A. Brainard and Donald H. Buckley Washington Jul. 1968 19 p refs
(NASA-TN-D-4668) CFSTI: HC$3.00/MF$0.65 CSCL 20K

The effect of crystal and order-disorder tranformations on friction and wear for Be–Co and FeCo alloys were studied in sliding friction experiments in vacuum at elevated temperatures. The results show that friction increases fourfold for the beryllium–cobalt alloy during tranformation and that friction remains high until the reverse or cooling transformation occurs. The friction and wear of Be–Co are markedly superior to 440-C stainless steel. The order-disorder transformation in FeCo increases friction by a factor of 30 and also significantly increases wear. Increased sliding speed and loading affect the transformation. The friction behavior during heating is in good agreement with the type of order-temperature relation in FeCo. Author

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N68-27158 California Univ., Berkeley.

SCATTERING OF A LASER BEAM BY RELATIVISTIC ELECTRONS

Robert Edward Pechacek (Ph.D. Thesis) 1966 87 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8623

Relativistic effects of the scattering of electromagnetic radiation from electrons are discussed, under the assumption that the scattered electric field is a linear function of the incident field. It is shown that the spectral intensity of scattered radiation is proportional to the ensemble average of the product of spectral density of density fluctuations times a function of relativistic origin. This relativistic function depends on the velocity of the scattered, the position of the observer, and the direction of the incident radiation. The concept of a "restricted particle" is developed to describe scattering that occurs in a finite volume. One effect of the finite volume is to broaden the spectrum of radiation scattered from a distribution of particles with identical velocities. A second effect, which is independent of the size of the finite volume, is a first order (in v/c) difference in intensity between radiation scattered from free particles and from restricted particles. Dissert. Abstr.

N68-27413# National Bureau of Standards, Washington, D. C. Inst. for Basic Standards.

A LASER-SOURCE INTEGRATING SPHERE REFLECTOMETER

Gerhart J. Kneissl and Joseph C. Richmond Feb. 1968 70 p refs
(Contract AF 33(615)-65-5005)
(NBS-TN-439) GPO: $0.45

A reflectometer was developed for measuring the absolute spectral reflectance of materials at temperatures up to 2500°K. The equipment included (1) a helium–neon laser as the source, capable of operation at 0.6328, 1.15 or 3.39 μm, (2) a 35 cm diameter integrating sphere coated with sodium chloride, (3) a lead sulfide detector, and (4) a radio frequency generator for heating the specimen by induction. A spike filter transmitting at the laser wavelength in front of the detector absorbed most of the background radiation from the hot specimen, and a chopped incident beam together with synchronous amplification of the signal from the detector was used to eliminate the effect of the remaining background radiation. The integrating sphere could be evacuated, or operated under a slight positive pressure of purified helium. An error analysis showed that the measured absolute reflectances are in error by less than one percent. Preliminary data are presented for thoria, tungsten and graphite. Graphite was found to be stable in reflectance on heating to 2150°K in vacuum. Both thoria and tungsten were somewhat unstable in reflectance on heating in vacuum. Author

N68-27716 Utah Univ., Salt Lake City.

THE EFFECTS OF BUFFER GAS PRESSURE AND CONCENTRATION ON HOLE BROADENING IN GAS LASER SYSTEMS

Maylin Henry Dittmore (Ph.D. Thesis) 1967 169 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-10722

The effects of thermal elastic collisions on upper state excited atoms in a laser system are considered. A model, wherein the atoms are considered to be smooth, frictionless spheres, is employed in a classical treatment of the thermal collisions. The probability of an excited atom being transferred from one position on the inhomogeneously broadened distribution to another is calculated. A periodic approximation of the error integral is used to simplify the expression for the transfer probability. From the transfer probability functions the broadening of the natural line width due to hard collisions and the broadening of the holes in the excited atomic distribution due to soft collisions are calculated. Measurements of hole widths using the concentration ratio and total pressure as parameters are made on the 6328 — Ne–He laser system. Measurements are found to agree quite well with the calculations. Dissert. Abstr.

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N68-26962 Iowa State Univ. of Science and Technology, Ames.

FATIGUE SOFTENING OF COPPER AND COPPER–ALUMINUM ALLOYS

Joe Howard Doyle (Ph.D. Thesis) 1967 90 p
(Contract W-7405-ENG-82)
(IS-T-137) Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8907

Fatigue softening has been studied in the copper–aluminum alloy system using copper and alloys containing 2, 3.5, and 7 weight percent aluminum. The samples were prestressed in a partial tensile test and then cyclically loaded in push-pull fatigue. The magnitude of fatigue softening after cyclic loading was found by flow stress measurements and indentation hardness testing to vary directly with the stacking fault energy of the alloys. The Bauschinger effects which occur during the first cycle increase with increasing aluminum content in these alloys, thus they must be taken into account to prevent them from masking the effects of fatigue softening. Dissert. Abstr.

N68-26984# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.

EFFECTS OF PRESSURE AND VIBRATION RATES UPON FRETTING DAMAGE

S. Fred Calhoun Apr. 1968 14 p refs
(RIA-68-896; AD-668658)

Steel specimens identical in composition, surface finish, and hardness, lubricated by the same grease were tested at four

different vibration rates and three different pressures. The results indicate that an increase in pressure over the range used resulted in increased fretting damage. Results of the vibration frequency tests indicate that the fretting damage is greatest at an intermediate rate and decreases at a higher or lower vibration rate. There is some indication that the load also may have had an influence upon the damage at certain vibration rates. There is apparently an interrelationship between loads and frequencies upon fretting.
Author (TAB)

N68-27071# Oak Ridge National Lab., Tenn.

PHYSICAL, MECHANICAL, AND IRRADIATION PROPERTIES OF THORIUM AND THORIUM ALLOYS

Joseph P. Hammond Apr. 1968 70 p refs
(Contract W-7405-ENG-26)
(ORNL-4218) CFSTI: HC $3.00/MF $0.65

Physical and mechanical property data on thorium and thorium alloys were reviewed, and information pertinent to nuclear reactor application is compiled. Author (NSA)

N68-27099 California Univ., Berkeley.

EFFECT OF HIGH PRESSURE ON THE PROPERTIES OF SOME METALS

Donald Louis Raimondi (Ph.D. Thesis) 1966 105 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8630

An equation of state for aluminum to the Debye approximation has been obtained from the determination of the Debye temperature, as a function of pressure from 0 to 135 kbars. The variation was determined by use of the Bloch–Grüneisen equation in fitting experimental resistance-temperature data at various pressures. The zero pressure thermodynamic properties of aluminum calculated from the equation of state agree quite well with the corresponding observed quantities. It is found that the Grüneisen ratio is a linear function of volume at pressures above 40 kbars. The effect of high pressure on the Mössbauer spectrum of Fe^{57} in iron was studied to a pressure of 140 kbars with particular interest in the transition of α-iron to the hcp phase. In order to better understand the interaction of the ferromagnetic host with an impurity atom in a dilute alloy, the Mössbauer spectrum of Fe^{57} in nickel metal was studied to 80 kbars. Dissert. Abstr.

N68-27116# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CORROSION OF METALS AND ALLOYS

25 Aug. 1967 70 p refs Transl. into ENGLISH from Korroziya Metallov i Splavov (Moscow), no. 2, 1965 p 80–102, 136–147, 305–314, 332–350
(FTD-MT-24-99-67; AD-668094)

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N68-27117# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CORROSIONAL AND ELECTROCHEMICAL BEHAVIOR OF TITANIUM AND ITS ALLOYS IN WET-PROCESS PHOSPHORIC ACID [KORROZIONNOYE I ELEKTROKHIMICHESKOYE POVEDENIYE TITANA I EGO SPLAVOV V EKSTRAKTSIONNOY FOSFORNOY KISLOTE]

V. V. Andreyeva, V. I. Kazarin, and T. I. Kudryashova *In its* Corrosion of Metals and Alloys 25 Aug. 1967 p 23–32 refs (See N68-27116 16-17)

The evaluation of the corrosion resistance and electrochemical properties of Ti in wet-process phosphoric acid is of major interest in view of the planned expansion of the production of phosphoric fertilizers in the USSR. The experiments with technical Ti as well as with Ti alloys were performed with the aid of an electronic potentionstat, while the potentials were measured by compensation method with respect to a calomel reference electrode and converted in terms of a normal hydrogen electrode. Findings: the corrosion rate of Ti in phosphoric-acid solutions is a function of the potential. In the presence of specific values of the potential Ti is capable of passing over to passive state. Ti in wet-process phosphoric acid is corrosion-resistant (corrosion rate up to 0.1 mm/year) at up to 40°C. The presence of Fe^{3+} preserves the passive state of Ti at up to 60°C, but at 60°C the corrosion rate then rises to 0.3 g/m^2-hr) (0.6 mm/year). Adding Mo to Ti increases the latter's corrosion rate, the more the higher the Mo content of the alloy is, owing to repassivation with respect to Mo as result of the presence of Fe^{3+} ions in the wet-process phosphoric acid. Adding Nb, on the other hand, improves the corrosion resistance of Ti in the acid. Author

N68-27118# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MECHANISM OF PROTECTION OF METALS FROM CORROSION WITH AMMONIA [MEKHANIZM ZASHCHITY METALLOV OT KORROZII AMMIAKOM]

I. L. Rozenfel'd and V. P. Persiantseva *In its* Corrosion of Metals and Alloys 25 Aug. 1967 p 33–42 refs (See N68-27116 16-17)

The authors decided to investigate the protective capacity of NH_3 as a function of its content in the atmosphere, as well as to investigate the effect of NH_3 on the electrochemical behavior of steel. The investigation pertained to NH_3 of 100% relative humidity at 25°C, on varying its concentration by placing in the reaction vessel NH_{4bOH} of various concentrations corresponding to ammonia vapor pressures of from 66.66 to 666.6 n/m^2 (0.5 to 5 mm Hg), with the corrosion being determined as a function of time until the appearance of first signs of corrosion on the steel specimens. These experiments showed that even insignificant concentrations of NH_3 in the atmosphere effectively protect steel against corrosion. The mechanism of the protection of steel by NH_3 is due to the hydration of NH_3 and the concomitant formation of NH_3 ions. The prior adsorption of hydroxyl ions on the (positively charged) surface of steel makes possible the adsorption of NH_3 ions on the metal surface, which leads to a sharp change in the ionization rate of Fe. Author

N68-27119# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ATMOSPHERIC CORROSION OF STEEL, ZINC, CADMIUM, COPPER, AND ALUMINUM IN VARIOUS MARITIME AND CONTINENTAL REGIONS [ATMOSFERNAYA KORROZIYA STALI, TSINKA, KADMIYA, MEDI I ALYUMINIYA V RAZLICHNYKH PRIMORSKIKH I KONTINENTAL'NYKH RAYONAKH]

G. K. Berukshtis and G. B. Klark *In its* Corrosion of Metals and Alloys 25 Aug. 1967 p 43–59 refs (See N68-27116 16-17)

The authors attempted to refine the formula for the mathematical dependence of the rate of metal corrosion on external conditions so as to take into account the effect of corrosion products, rainfall precipitation, and the contamination of air by SO_2. Specimens of steel, Cu, Zn, Cd and Al were exposed to open air as well as kept in atmospheric booths under conditions simulating storage in unheated warehouses, in various regions of the USSR. Corrosion rate was determined by weighing the specimens before and after the tests over various periods of time and this was combined with regular meteorological observations. The products forming at metal surfaces were analyzed for their content of SO_4^{2-} and Cl – ions and the duration of the wetting of metal (precipitation in hours per year) was recorded. Findings: the corrosion rate of all the five metals may vary markedly depending on environmental factors. SO_2 is a specific aggressor for nonferrous metals and particularly for Cd, and chlorides are specific aggressors for such metals as Al and Cu. It is shown that it is fundamentally possible to make scientifically substantiated predictions of the rate of metal corrosion. Author

N68-27146# Missouri Univ., Rolla.

MECHANISMS OF METALLIC CORROSION PROCESSES AND HYDROGEN EMBRITTLEMENT Final Report, 1962–1968

M. E. Straumanis Apr. 1968 26 p refs
(Contract Nonr-2296)
(AD-669006)

The exploratory studies were in four areas: (I) disintegration phenomena during corrosion and anodic dissolution of pure metals consisting of polycrystals and of single crystals, (II) disintegration and anodic behavior of semiconductors, used in the same forms, (III) attack and rates of corrosion of some metals (zone refined Fe, steel, Mg, Zn, TiOx solid solutions, and determination of the rates of oxidation of Ti(3+) to Ti(4+) in HF by strong acids, and (IV) hydrogen solubility in Zr and in Fe. Part (V) represents studies still in progress. Author (TAB)

N68-27180# Navy Dept., Washington, D. C.

DETERMINATION OF CAVITATION RESISTANCE OF MATERIALS WITH THE HELP OF MAGNETOSTRICTION VIBRATORS [OPREDELENIYE KAVITATSIONNOY STOYKOSTI MATERIALOV S POMOSHCH'YU MAGNITROSTRIKTSIONNOGO VIBRATOVA]

M. M. Pisarevskiy and A. F. Yerashov 19 Apr. 1968 25 p Transl. into ENGLISH from Energomashinostr. (Moscow), v. 9, 1957 p 38–39
(NIC-TRANS-2582; AD-668725)

Determination of cavitation resistance of materials with the help of magnetostriction vibrators—translation. TAB

N68-27193# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.

EFFECTS OF ALLOYING ON THE BRITTLE FRACTURE OF ZINC IN LIQUID MERCURY

M. H. Kamdar and A. R. C. Westwood Dec. 1967 25 p refs Submitted for publication
(Contract DA-31-124-ARO(D)-63)
(RIAS-TR-68-7C; TR-6; AD-668661)

The susceptibility of polycrystalline zinc to embrittlement by liquid mercury is markedly increased by alloying with as little as 0.2a/o of copper or gold in solid solution. To determine the cause of this phenomenon, a study has been made of the effects of 0.05 or 0.2a/o copper on the flow and fracture behavior of amalgamated zinc monocrystals and asymmetric bicrystals. Fracture stress data from these experiments were used in conjunction with a criterion for crack initiation to determine the influence of alloying on cleavage surface energy, gamma. It was found that alloying increased the critical resolved shear stress (gamma sub C) of amalgamated bicrystals by a factor of ten, and their fracture stresses by factors of two to four, but that gamma was increased only from 45 plus or minus 5 ergs/sq cm (pure zinc) to 60 plus or minus 7 ergs/sq cm. The significance of this and other observations is discussed, and it is concluded that the increased susceptibility to embrittlement by liquid mercury of polycrystalline zinc on alloying is not related to solute-induced changes in macroscopic flow stress, stacking fault energy, slip mode, or state of bonding, but in gamma sub C. Increasing gamma sub C inhibits the relaxation by plastic flow of stress concentrations at grain boundaries, and, in the presence of mercury, facilitates crack initiation. Author (TAB)

N68-27205# Argonne National Lab., Ill. Metallurgy Div.

LEVITATION MELTING OF METALS AND ALLOYS

J. W. Downey Dec. 1967 15 p refs
(Contract W-31-109-ENG-38)
(ANL-7398) CFSTI: HC$3.00/MF$0.65

Improved techniques for levitation melting, and designs of two levitation coils have been qualitatively evaluated. The coils are capable of levitating small quantities of a wide variety of molten metals and alloys. A molten charge can be helium-quenched to a solid and yet remain levitated. Levitation melting is advantageous for the preparation of alloys that require the addition of a small quantity of a specific isotope, such as for studies of the Moessbauer effect. Alloys can be cast to predetermined shapes with such rapid cooling that segregation is minimized. Author (NSA)

N68-27223# Rock Island Arsenal Lab., Ill. Research and Engineering Div.

STUDY OF CORROSION AND POROSITY OF ELECTRODEPOSITED COATINGS BY HYDROGEN DIFFUSION TECHNIQUE

Russell H. Wolff Mar. 1968 16 p refs
(RIA-68-717; AD-668657)

Hydrogen sorption was used in a study to determine whether corrosion of steel and porosity of coatings can be evaluated in this manner. Attempts to measure corrosion produced hydrogen on bare steel hydrogen detection probes resulted in visible rust film on the probe but hydrogen sorption was too small to be useful as an evaluation technique. For porosity tests hydrogen detection probes were cadmium plated to three thicknesses and were subjected to three test conditions: immersion in 2% HCl, or dilute caustic cyanide solution; cathodic charging; and a boil test. No conclusive differences were observed for hydrogen sorption in relation to thickness or porosity when immersion or cathodic charging conditions were used. There was an appreciable and progressive difference in hydrogen sorption with increased plate thickness in the boil test conditions. Application of the method to a detailed study of porosity and porosity related corrosion is recommended for the commonly used protective coatings for metals. Author (TAB)

N68-27238 California Univ., Berkeley.

SLIP DISTRIBUTION IN COPPER SINGLE CRYSTALS

Gollapudi Satyanarayana Murty (Ph.D. Thesis) 1966 91 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-8812

The aim of our investigation was to understand the strain hardening of face-centered cubic single crystals, as evidenced by the stress-strain curve and its relation to the strain distribution. The influence of initial dislocation substructure on the shape of the stress strain curve of copper single crystals oriented for single slip, and the associated slip distribution determined with selected-area replica and optical techniques was studied. With the increase in the amount of prestrain along [111], the slip bands nucleated more clearly at one corner of rectangular specimens and propagated in a correlated way. The growth of slip bands by clustering of the fine slip lines became more pronounced at higher stress levels. The slip-band appearance did not depend on the strain hardening rate, but correlated well with the stress level, regardless of the prestrain histories of the crystals. Dissert. Abstr.

N68-27267# Naval Ordnance Lab., White Oak, Md.

SYMPOSIUM ON TITANIUM NICKEL AND ASSOCIATED COMPOUNDS

Frederick E. Wang, ed. 20 Feb. 1968 230 p refs Proc. of Symp. held in Silver Spring, Md., 3–4 Apr. 1967
(NOLTR-68-16; AD-668696)

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16. NEUTRON DIFFRACTION STUDY OF $TiFe_xCo_{1-x}$ ALLOYS R. Nathans, F. Menzinger (Brookhaven Natl. Lab.), and S. J. Pickart 5 p ref (See N68-27283 16-17)
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N68-27268# Naval Ordnance Lab., White Oak, Md.

EQUIATOMIC BINARY COMPOUNDS OF HAFNIUM WITH TRANSITION ELEMENTS OSMIUM, IRIDIUM AND PLATINUM; FURTHER COMMENTS ON THE TITANIUM NICKEL TRANSITION

Frederick E. Wang and Donald W. Ernst *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 8 p refs (See N68-27267 16-17)

By means of single crystal X-ray diffraction methods, an underlying structural similarity among HfOs, HfIr and HfPt was established. Based on low-temperature (below −100°C) precession photographs, the existence of the previously anticipated M_f temperature in TiNi was confirmed. This evidence further supports the existence of unique martensitic transition bands in the TiNi, ZrPd and HfPt series of equiatomic binary compounds. Author

N68-27269# Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). Mataalinstituut.

THE SHAPE MEMORY EFFECT AND THE MARTENSITIC TRANSFORMATION OF TITANIUM NICKEL

R. G. de Lange and J. A. Zijderveld *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 17 p refs (See N68-27267 16-17)

The object of this investigation is to provide an explanation of the shape memory effect in TiNi with an equi-atomic composition. After a plastic deformation at room temperature of a wire or plate of TiNi, this material appears to remember its undeformed shape when it is heated above 90°C. It is assumed that the plastic deformation at room temperature is realized by martensitic transformation. This transformation takes place in a preferred orientation which depends on the direction and the sign of mechanical stress. On heating the oriented low temperature phase re-transforms to the original structure and annihilates the plastic deformation. X-ray texture measurements of reflections of the low-temperature phase have shown the existence of a relation between an applied stress and the texture. The results have shown a marked difference in texture of martensite formed by tension and martensite formed by compression. Although the crystal structure of the low-temperature phase is unknown, these results give an explanation of the memory-effect and any proposed crystal structure or orientation-relation should fulfill the relations between stress and texture. Author

N68-27270# McMaster Univ., Hamilton (Ontario). Materials Research Unit.

OBSERVATIONS OF THIN CRYSTALS OF TITANIUM NICKEL IN PRE-MARTENSITIC STATES

K. Chandra and G. R. Purdy *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 14 p refs (See N68-27267 16-17)

Thin films of TiNi were examined in the temperature range 0°–200°C, using transmission electron microscopy and selected area diffraction. The CsCl diffraction patterns are accompanied by strong localized diffuse scattering, which becomes more pronounced as the temperature is reduced, approaching that of a phase transformation. A series of experiments designed to determine the directions of maximum diffusely scattered intensity suggest that these are <210> and <321>, and that scattering is largely confined to reciprocal lattice directions subtending small angles with the incident electron beam. Since the phase transformation is thought to be of the second kind, and diffusionless, the results are interpreted in terms of large amplitude, short wavelength atomic displacements, reflecting incipient mechanical instability. Several diffraction patterns and dark-field photomicrographs are presented to indicate the scale of the domain structure of the transformation product. Author

N68-27271# Tokyo Univ. (Japan). Dept. of Metallurgy.

INTERNAL FRICTION AND RELATED PROPERTIES OF TITANIUM NICKEL INTERMETALLIC COMPOUND

R. R. Hasiguti and K. Iwasaki (Inst. of Phys. and Chem. Res., Saitama, Japan) *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 12 p refs (See N68-27267 16-17)

Internal friction and elastic moduli of the intermetallic compound TiNi were measured as a function of temperature from −170°C to 800°C. There appear in the internal friction curve two well defined peaks at −70°C and 600°C, respectively, a small peak at 350°C and a group of several small sharp peaks in the temperature range from −50°C to 40°C. The elastic modulus has a positive temperature coefficient in the temperature range from 40°C to 520°C. These results are discussed in terms of the crystal structure model of Wang and others. Author

N68-27272# Commonwealth Scientific and Industrial Research Organization, Sydney (Australia). Tribophysics Div.

NUCLEAR MAGNETIC RESONANCE AND SUSCEPTIBILITY MEASUREMENTS IN TITANIUM COBALT

G. W. West *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 8 p refs (See N68-27267 16-17)

Nuclear magnetic resonance and magnetic susceptibility measurements were made at 295°K and 77°K on titanium-cobalt alloys over a range of composition near the equiatomic value and also on ternary alloys near the composition Ti_2NiCo. The measurements in TiCo suggest that there may be a small range of solid solution for cobalt-rich alloys near the equiatomic composition. There is a large positive Knight shift for the Co^{59} resonance in all TiCo alloys. The Knight shift and the susceptibility are substantially larger at the lower temperature presumably due to a large contribution from an orbital interaction. For the ternary compounds both the Knight shift and the susceptibility are smaller and it is postualted that the orbital contribution was eliminated. Author

N68-27273# Naval Ordnance Lab., White Oak, Md.

SOME CONSIDERATION OF THE ELASTIC PROPERTIES OF TITANIUM NICKEL IN THE VICINITY OF TRANSFORMATION TEMPERATURE

A. G. Rozner and S. Spinner (NBS, Washington, D. C.) *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 19 p refs (See N68-27267 16-17)

Young's modulus, shear modulus, and internal friction of the TiNi intermetallic compound were measured as a function of temperature. The anomalous behavior of this compound in the vicinity of transformation temperature is compared with the discontinuous changes of Young's modulus in chromium and other materials. Evidence of higher order transformation occurring in TiNi is presented and substantiated in light of the discontinuities in elastic moduli and specific heat at the transformation temperature. Author

N68-27274# California Univ., Davis. Coll. of Engineering.

HIGH TEMPERATURE CREEP MECHANISM OF TITANIUM NICKEL

A. K. Mukherjee *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 13 p refs (See N68-27276 16-17)

Polycrystalline specimens of the intermetallic compound TiNi were tested in tension in the temperature range 700–1000°C. The specimens were observed to deform uniformly over the gage length until the very end of deformation, when it failed by necking. It was noted that the steady state flow stress was independent of the strain and was a function only of the temperature and strain rate. The shear strain rate $\dot{\gamma}$ was given by $\dot{\gamma} \propto \tau^n$ where $n = 3.0 \pm 0.2$, τ was the shear stress, and n was independent of temperature. The apparent activation energy for creep was found to be 60.0 ± 3.0 Kcal/mole and was independent of stress. The result strongly suggests that a viscous creep process, as first formulated by Weertman, is probably the rate-controlling mechanism for this compound in the stress and temperature range investigated. Author

N68-27275# Naval Ordnance Lab., White Oak, Md.

THE IRREVERSIBLE CRITICAL RANGE IN THE TITANIUM NICKEL TRANSITION

Frederick E. Wang, Bernard F. De Savage, William J. Buehler, and William R. Hosler (NBS, Gaithersburg, Md.) *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 24 p refs (See N68-27267 16-17)

Through an investigation of the transport and other related thermodynamic properties of TiNi at and around its "martensitic" transition temperature, the existence of a critical range extending over a 60 degree centigrade interval is characterized. Within this critical range, phase transition is second-order with anomalous heat capacity changes. Irreversibility of various properties within the critical range is interpreted in terms of irreversible shear movement of atoms. By inference, based on transport data, the band structure of TiNi is a single or "nearly" single positive band within the temperature range investigated. The postulate, that part of the valence electrons undergo a "covalent" "conduction" electronic state transformation, in the course of the 60 degree centrigrade interval second-order transition, is consistent in a large measure with experimental data. Author

N68-27278# National Bureau of Standards, Washington, D. C.

SOFT X-RAY SPECTROSCOPY OF ALLOYS: TITANIUM NICKEL AND THE NICKEL-ALUMINUM SYSTEM

J. R. Cuthill, A. J. Mc Alister, and M. L. Williams *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 12 p refs (See N68-27267 16-17)

Meaningful comparisons can now be made between the soft X-ray spectra of pure metals and theoretical densities of states distributions. The comparison of the $Ni\text{–}M_3$ spectrum with theoretical results is shown as an example. Also, useful information can now be obtained from alloy spectra although the analysis of alloy spectra involves all of the problems inherent in the interpretation of pure metal spectra plus additional problems. Overlapping spectra and more complex absorption corrections are two additional problems discussed. In fact, the soft X-ray spectroscopy technique should provide a crucial test of theoretical results on alloy systems. Spectra from a series of Al–Ni compositions and the Ni–M spectrum from TiNi are discussed. Author

N68-27280# Illinois Univ., Urbana.

LONG RANGE ORDER IN TITANIUM IRON

H. Okamoto and Paul A. Beck *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 1 p refs (See N68-27267 16-17)

Preliminary results obtained with a diffractometer, using crystal monochromated CuK_α radiation and step scanning with a scintillation counter and a pulse height analyzer indicated that annealing at 1200°C gives $S \cong 0.87$ and at 600°C $S \cong 0.98$. The alloy was prepared by arc melting and it was homogenized at 1200°C for three days in an evacuated and sealed fused silica capsule. The crushed powder was reannealed in one instance at 1200°C for one minute, in another at 600°C for 30 minutes. Both powder specimens gave sharp X-ray diffraction lines, with the $K_{\alpha 1}$, α_2 doublet well resolved at the higher Bragg angles. Author

N68-27281# Materials Research Corp., Orangeburg, N. Y.

AN EXPERIMENTAL STUDY OF THE COMPOUND TITANIUM COBALT USING HIGH TEMPERATURE X-RAY DIFFRACTOMETRY

A. Iannucci, A. A. Johnson, E. J. Hughes, and P. W. Barton *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 7 p refs (See N68-27267 16-17)

The experimental study on the phases of equilibrated and slowly cooled specimens of titanium-cobalt was extended using high temperature X-ray diffractometry and metling point determination to establish the approximate positions of the TiCo phase field boundaries. Ten compositions ranging from 44.80 to 54.06 at.% titanium were used for the diffractometry, and a single specimen containing 48.30 at.% was used for the melting point determination. Experimental data obtained from the diffraction traces are discussed, and approximate solidus and liquidus lines based on the melting point determination are shown. B.S.D.

N68-27282# Naval Research Lab., Washington, D. C.

A MECHANISM FOR THE HIGH TEMPERATURE TRANSFORMATION IN TITANIUM NICKEL AND THE RESULTANT PREMARTENSITIC TITANIUM NICKEL (II)

Forrest L. Carter *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 21 p refs (See N68-27267 16-17)

A mechanism is proposed for the high temperature transformation of TiNi from a CsCl structure to the TiNi(II) structure. The driving force for the transformation is discussed using Pauling's metallic radii and is considered as an attempt of the components to achieve more normal valencies and interatomic distances. The distortion of the TiNi(II) structure prior to and during the 160°C martensitic transformation is considered. Unit cell dimensions are proposed for a small TiNi(III) structure which is compatible with the apparent cell edge tripling of the TiNi(I) structure. Author

N68-27283# Naval Ordnance Lab., White Oak, Md.

NEUTRON DIFFRACTION STUDY OF TITANIUM IRON COBALT ALLOYS

Stanley J. Pickart, R. Nathans (Brookhaven Natl. Lab.), and F. Menzinger (Brookhaven Natl. Lab.) *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 5 p ref (See N68-27267 16-17)

Neutron diffraction measurements indicate that $TiFe_xCo_{1-x}$ alloys with x = .45, .50, and .55 are completely ordered in the CsCl lattice. Polarized neutron measurements on alloys with x = .45 and .55 suggest that the observed magnetization arises primarily from the Co and Fe atoms and is fairly well localized. Author

N68-27284# Naval Ordnance Lab., White Oak, Md.

MAGNETIC PROPERTIES OF THE PSEUDOBINARY SYSTEM TITANIUM IRON COBALT

B. F. de Savage *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 8 p refs (See N68-27267 16-17)

The salient features of a study of the magnetic properties of the pseudobinary system $TiFe_xCo_{1-x}$ is reported. The samples were prepared by arc-casting the proper stoichiometric proportions of Ti, Fe, and Co on a water cooled copper hearth in an argon atmosphere. A balance magnetometer in which a sample is weighed in an inhomogenous magnetic field, was used to determine the magnetic susceptibility between 65° and 300°K. The temperature dependence of the inverse susceptibility is discussed along with the paramagnetism of the system. B.S.D.

N68-27285# Northwestern Univ., Evanston, Ill. Dept. of Materials Science.

A STUDY OF THE RELATIVE DUCTILITIES OF TITANIUM IRON, TITANIUM COBALT AND TITANIUM NICKEL

R. Scholl, David J. Larson, Jr., and E. J. Freise *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 13 p refs (See N68-27267 16-17)
(Contract Nonr-1228(31))

A study of the relative ductilities of binary and ternary compounds of the type TiX where X is Fe, Ni, Co or combinations of these, was performed by means of three point bending tests at room temperature. The general results of these studies indicate that TiFe or TiCo form a continuous series of solid solutions with TiNi provided the concentration of titanium remains at 50 atomic percent. The ductility of the binary compounds increases in the order TiFe, TiCo, TiNi. Also, nickel additions to TiFe and TiCo increase their relative ductilities. These ductility changes can be correlated with the increasing electron to atom ratio as the nickel concentration is increased. In turn, the increasing electron to atom ratios are taken to indicate an increasingly metallic character in the bonding of the compounds. This conclusion is confirmed by x-ray lattice parameter measurements. Author

N68-27319 Cornell Univ., Ithaca, N. Y.

ADHERENCE AND WETTABILITY OF NICKEL, NICKEL-TITANIUM ALLOYS, AND NICKEL-CHROMIUM ALLOYS TO SAPPHIRE

John Earl Ritter, Jr. (Ph.D. Thesis) 1966 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-3794

With the emergence of the space age, there is an increasing demand for high temperature, load-bearing materials. In an attempt to satisfy this need, technologists have turned to whisker-reinforced metals. It has been postulated that by reinforcing nickel with Al_2O_3 whiskers, strengths superior to those of the best current nickel alloys can be achieved. The purpose of this research is to investigate the factors involved in the wetting and adherence of nickel/nickel alloys to sapphire (single crystal $\alpha - Al_2O_3$). Sessile drop experiments were conducted in four different atmospheres to determine the effect of atmosphere on angle (wettability) of the metals on sapphire and the liquid-gas surface tension of pure nickel. Shear tests were performed on the solidified sessile drops to measure the bond strength between the metal and ceramic. The alloy additions chosen were titanium and chromium since both enhance the wetting of nickel on Al_2O_3. Dissert. Abstr.

N68-27373# American Meteorological Society, Boston, Mass.

APPLICATION OF THE TOPLER METHOD TO THE STUDY OF INHOMOGENEITIES IN SYNTHETIC CORUNDUM CRYSTALS

N. M. Melankholin *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 166–171 refs (See N68-27363 16-18)

In the method described, the transparent object is illuminated by a condenser with a collimated parallel or weakly convergent beam of light, and is examined in the transmitted light by a short focus telescope. Beam and sample positioning is discussed. Details are also given on a special instrument developed for making observations by the Topler method. This consists basically of a collimator and a long-focus weak microscope secured to a stand, with a sample holder between them. The holder is constructed so that the sample may be moved horizontally or vertically, or turned around the vertical axis and, to some extent, around the horizontal axis. The best samples for observation by this method are considered to be plane-parallel plates polished on two sides; plates with ground surfaces, as well as half-boules and their fragments, may be examined only by immersing them in a plane-parallel cell filled with immersion liquid. It is also pointed out that mosaic structure in pure form may be observed by the Topler method. M.G.J.

N68-27399*# IIT Research Inst., Chicago, Ill.

PROPERTIES OF TANTALUM CARBIDE-GRAPHITE AND NIOBIUM CARBIDE-GRAPHITE COMPOSITES

Y. Harada and S. A. Bortz [1967] 27 p refs Presented at the 69th Ann. Meeting of the Am. Ceram. Soc., New York, 2 May 1967
(Contract NASr-65(09)14-003-909)
(NASA-CR-85164) CFSTI: HC$3.00/MF$0.65 CSCL 11D

Tantalum carbide–graphite and niobium carbide–graphite composites were prepared by hot-pressing at 3000° to 3200°C. The effect of metal carbide content upon properties such as flexural strength, thermal expansion, compressive deformation, and electrical resistivity were determined, both parallel and perpendicular to grain direction. The results show that with increasing carbide content the following general trends are observed: higher strength, decreasing anisotropy, decreasing resistance to high temperature plastic deformation, and decreasing electrical resistivity. Author

N68-27420 California Univ., Berkeley.

THE MELTING AND SOLIDIFICATION OF GALLIUM

Philip Robbins Pennington (Ph.D. Thesis) 1966 147 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8624

The growth rates of five singular faces on single crystals of gallium were measured as a function of supercooling, both with and without the presence of dislocations, and the rate laws and nucleation energies were determined. Nucleation of melting was inhibited by removal of surface oxide. The growth rates were exponential for dislocation-free growth, indicating that two-dimensional nucleation is the rate-limiting process, and the edge energies of the nuclei indicate that the growing interface is diffuse. Dislocation-free rate laws that differ for high and low growth rates were found for two of the singular planes and were interpreted as being caused by growth with and without interference of growth steps. Melting interfaces were found to lie on crystal faces at lower values of superheating, but not at higher values. Removal of the oxide coating resulted in a much greater tendency for the melting to follow crystal faces, and allowed the solid to be heated at least 0.1 degree above its melting point without the nucleation of the liquid phase. Dissert. Abstr.

N68-27437*# Solar, San Diego, Calif.

STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS Interim Technical Report, 8 Jun. 1967–8 Mar. 1968

M. J. Klein May 1968 73 p refs
(Contract NAS7-469)
(NASA-CR-95189; RDR-1534-7; ITR-2) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The effects of interstitial sinks (reactive metals in which interstitials concentrate) on the interstitial concentration, the structure and the creep behavior of refractory metals were studied. The systems investigated in greatest detail thus far are titanium base interstitial sinks with a columbium base refractory alloy, D43. The systems, Ti/T222, Ti/TZM and Hf/T222, were also studied. The grain structures of TZM and T222 specimens annealed with a titanium sink did not differ from the grain structures of specimens annealed without a titanium sink. Although titanium is an interstitial sink for carbon in TZM, it is not a sink for the carbon in T222. A parallel study of the grain structure in T222 exposed to hafnium suggests that this more reactive metal is an interstitial sink for T222. An experimental method to determine the chemical potential of interstitials in refractory metals was investigated using titanium-columbium alloys. The oxygen concentration in the titanium-columbium alloys was correlated with the free energy of formation of calcium oxide. The method has good potential but additional work will be required to critically evaluate its capabilities. Author

N68-27446*# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.

DIFFUSION MEASUREMENTS USING A MODIFIED KNUDSEN TECHNIQUE

D. J. Fray [1966] 10 p refs Presented at the Ann. Meeting of the AIME, Los Angeles, Feb. 1967
(Grant NsG-496)
(NASA-CR-82496) CFSTI: HC$3.00/MF$0.65 CSCL 11F

By measuring the weight loss out of a Knudsen cell the vapor pressure of the escaping species can be calculated. If the only way this species can enter the Knudsen cell is by diffusion through a foil, the steady state weight loss is also the diffusion flux. The composition of the surface of the foil in the cell is given by the vapor pressure in the cell and the thermodynamics of the system. The composition of the other foil surface can be controlled by the external vapor pressure of the diffusing material. Using the above data and the foil thickness, the diffusion coefficient can be calculated from Fisk's first law. This technique has been used to study the diffusion of zinc through thin silver foil in the temperature range 500–500°C. Author

N68-27448*# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.

AN INVESTIGATION OF STRAIN CYCLING BEHAVIOR OF 7075-T6 ALUMINUM UNDER COMBINED STATE OF STRAIN Annual Progress Report, 1 Oct. 1966–30 Sep. 1967

S. Y. Zamrik 1 Oct. 1967 80 p refs Presented at Soc. of Exptl. Stress Analysis Meeting, Chicago, Nov. 1967
(Grant NGR-39-009-034)
(NASA-CR-89211; APR-3) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The uniaxial and biaxial low cycle fatigue life of 7075-T651 aluminum alloy IN anticlastic bending is investigated. Uniaxial data is obtained from a cantilever specimen and rhombic plate specimens are used for nominal strain biaxiality of 1:-1, 1:-0.9, 1:-0.8 and 1:-0.5. Experimental data is discussed on the basis of maximum strain range, maximum shear strain range and octahedral shear strain range. Author

N68-27473*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF STRESS RATIO IN FATIGUE-CRACK GROWTH IN 7075-T6 ALUMINUM-ALLOY SHEET

C. Michael Hudson and Joseph T. Scardina [1967] 24 p refs Presented at the Natl. Symp. on Fracture Mech., Bethlehem, Pa., 19–21 Jun. 1967
(NASA-TM-X-60125; L-5584) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Axial-load fatigue-crack-propagation tests were conducted on 12-inch wide sheet specimens made of 7075-T6 aluminum alloy. These tests were made at stress ratios R (ratio of the minimum stress to the maximum 5 to 50 ksi (34 to 340 MN/m^2) to study the effects of stress ratio on fatigue-crack growth. The fatigue-crack-propagation data were analyzed using Paris' stress-intensity analysis. The data from tests at negative R values fell into a relatively narrow scatterband along with the results from the R = 0 tests on a plot of rate against stress-intensity range. Apparently, the compression portion of the loading cycle did not significantly affect crack growth in these tests. The data from tests at different positive stress ratios fell into discrete bands on these plots. These bands varied systematically with R, that is, the higher the stress ratio at a given value of ΔK, the higher the rate of fatigue-crack growth. This spread in rates was small at the lower stress-intensity range, but became progressively larger as the stress-intensity range was increased. The fracture surfaces of the specimens changed from the normal mode to a shear mode within a reasonably narrow range of crack growth rates for all R values. The stress-intensity range at transition was approximately a constant for tests at negative stress ratios. Author

N68-27531*# IIT Research Inst., Chicago, Ill.

METAL CARBIDE-GRAPHITE COMPOSITES

Y. Harada 28 Apr. 1968 41 p refs
(Contract NASr-65(09))
(NASA-CR-95222; IITRI-G6003-Q7) CFSTI: HC $3.00/MF $0.65
CSCL 11D

Carbon powders of various sizes, shapes, and processing histories were incorporated into composites of 47 vol% NbC, in order to determine their effects on such properties as strength, thermal expansion, high temperature deformation resistance, and degree of anisotropy. Creep tests conducted at high temperatures show: (1) The best creep resistance in both grain directions is exhibited by composites incorporating M2 graphite. (2) A heat treatment of one hour at 2500°C does not materially change creep behavior of NbC–C composites. (3) Examination of compressive creep behavior at 2700°C, 2000 psi for 30 minutes, reveal changes in length of less than 1% in either grain direction. An evaluation of densification aids for TaC–C composites shows that 5 vol% of Mo, W, or NbC in composites containing about 45 vol% TaC yields dense, well-bonded composites with excellent high temperature properties. The preliminary data indicate that additives of about 50 vol% carbide content exhibit better creep resistance than equivalent TaC–C composites without additives. M.G.J.

N68-27590# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DEPENDENCE OF DIMENSIONS OF CRATER ON HARDNESS OF TARGET [ZAVISIMOST' RAZMEROV KRATERA OF TVERDOSTI MISHENI]

Yu. I. Fadeyenko *In its* J. of Appl. Mech. and Tech. Phys. 16 May p 185–188 refs (See N68-27575 16-23)

Several experiments were carried out in which Nichrome projectiles measuring 160 ± 5μ in diameter were explosively accelerated into aluminum-alloy and steel plates. The experiments were conducted under vacuum in order to avoid air braking. Constant acceleration conditions were maintained throughout the tests so that impact velocity and the size of the particle did not change from test to test. A target area containing 20–25 craters was investigated so as to determine the depth and the diameter of the individual craters. The quantity of projectile material remaining in the target after impact could be disregarded because earlier experiments had shown that the amount of projectile left in the craters is only 3–8%. Test results obtained for various target materials are summarized and illustrated. Author

N68-27612*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE INFLUENCE OF CRYSTAL STRUCTURE, ORIENTATION AND SOLUBILITY ON THE ADHESION AND SLIDING FRICTION OF VARIOUS METAL SINGLE CRYSTALS IN VACUUM (10^{-11} TORR)

Donald H. Buckley [1967] 31 p refs Presented at the Am. Soc. for Testing and Mater. and the Am. Soc. of Lubrication Engr. Symp. on Adhesion, Toronto, 1–2 May 1967
(NASA-TM-X-60090) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Friction and adhesion characteristics were measured in vacuum (10^{-11} torr), for various metal single crystals. The (100), (110) and (111) planes of copper, the (111) plane of nickel, the (0001) plane of cobalt and the (110) plane of tungsten were studied. Experiments were conducted with matched planes and directions in contact, as well as mismatched orientations of copper. The (111) plane of copper was also examined in contact with nickel, cobalt and tungsten crystals. Measurements included: adhesion before sliding, friction during sliding and adhesion after sliding. The results indicate that sliding markedly increases the adhesion of clean metals in contact. The friction and adhesion of copper is highly anisotropic. Adhesion was observed for the insoluble couple copper-tungsten after sliding. Crystal structure was found to influence adhesion and friction. Author

N68-27655 Pittsburgh Univ., Pa.

MECHANISM OF INTERFACE REACTIONS BETWEEN SILICA AND ALUMINUM DISSOLVED IN IRON MELTS

Witold Marian Wojcik (Ph.D. Thesis) 1966 75 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-9734

Deoxidation of steel with silicon followed by aluminum results in formation of non-metallic inclusions which usually have compositions far removed from equilibrium. The search for obstacles preventing or delaying establishment of equilibria in those metal-oxide systems forms the subject of this study, focussed on the phase boundary reactions. A method for studying high temperature reactions at the phase boundaries between one liquid and one solid phase has been developed for this purpose. The solid phase is formed into shaped, capillary tubes which are to contain the convection free liquid phase. After specific reaction times the tubes holding the liquid are quickly frozen. The cross sections of the reacted, frozen specimens are subjected to a localized microanalysis by an electron probe, in order to establish concentration distributions as functions of the distance from the interface for specific, chosen reaction times. Analysis of such distributions of the reaction products or of the reactants serves to establish the reaction mechanism involved. Dissert. Abstr.

N68-27657 Arizona Univ., Tucson.

THE FRACTURE MODE OF PATENTED EUTECTOID STEEL WIRE

Paul Clayton Simmons (Ph.D. Thesis) 1967 327 p
Available from Univ. Microfilms: HC $14.85/MF $4.20 Order No. 67-10318

The fracture characteristics of patented eutectoid steels drawn to ultimate strengths as high as 600 KSI were analyzed. Desirable fracture characteristics were found to be associated with relatively high values of the following: manganese content, electrical resistivity, fault probability, [110] peripheral texture, strain as measured in a tensile test, and residual longitudinal tensile macrostress at the specimen surface; and relatively low values of the following: phosphorous content, nitrogen content, mechanical anisotropy, yield strength, and strain hardening coefficient. Evidence of two major precipitation hardening reactions was found for specimens strain aged at 149°C. The fracture characteristics were found to be drastically affected by the degree of strain aging, especially at the higher strength levels. Two distinct stages of recovery were found to occur before recrystallization began. Analyses of tensile test data indicated that very high homogeneous strain values were associated with second stage recovery. Dissert. Abstr.

N68-27659 Pittsburgh Univ., Pa.

DETERMINATION OF THE ACTIVITIES OF SOLID COBALT-PLATINUM ALLOYS

Robert James King (Ph.D. Thesis) 1967 119 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-9720

In this investigation, the activities of cobalt in solid cobalt-platinum alloys were measured at temperatures of 800°, 900°, 950°, and 1000°C, using a galvanic cell involving stabilized zirconia as a solid oxide electrolyte. A modification of a technique developed by Tret'yakov and Schmalzried for work on spinels was employed in this work. In this technique, a comparatively large amount of the powdered cobalt-platinum alloy was mixed with CoO powder, and this mixture was placed within a stabilized zirconia tube at the closed end of the tube. The other end of the zirconia tube was closed off. The apparatus was arranged so that the free volume within the stabilized zirconia tube was minimized. Upon heating the zirconia tube to the desired temperature, the activity of cobalt in the alloy controlled the oxygen pressure developed as a very small amount of the CoO decomposed. The potential developed across the stabilized zirconia was a direct measure of the oxygen pressure inside the zirconia tube, referred to the oxygen pressure in the air around the outside of the zirconia tube as the reference electrode. Cells of this design equilibrated very rapidly and were quite stable. Dissert. Abstr.

N68-27667*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DEVELOPMENT OF A Co-W FERROMAGNETIC, HIGH-TEMPERATURE, STRUCTURAL ALLOY

R. L. Ashbrook, A. C. Hoffman, G. D. Sandrock, and R. L. Dreshfield Washington 1967 10 p refs Presented at the Intern. Congr. on Magnetism Sponsored by the Am. Inst. of Phys., Boston, 11–16 Sep. 1967

(NASA-TM-X-52331) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Discussed is the development of alloys with improved high temperature strength and good high temperature magnetic properties for rotors used in space power generators. Because Co has the highest Curie temperature of any metal and is a good base for high temperature alloys, a NASA superalloy, Co-25--1Ti-1/2 Zr-1/2 C, was chosen for further study. Modifications of this alloy were screened for magnetic induction (H = 100 Oe) over a range of temperatures. For increasing W, Curie temperature decreased for the base Co-XW-1Ti-1/2 Zr-1/2 C, and B_{max} above 1000°F decreased. Below 1000°F, low W alloys show B_{max} vs. T inflections due to instability of the fcc phase. Stability of the fcc increased with increasing W and Fe. A preferred alloy, Co-7-1/2 W-2-1/2 Fe-1Ti-1/2 Zr-1/2 C, was evaluated for magnetic and mechanical properties in cast form and for mechanical properties as sheet. After aging at 1700°F for 72 hours, this alloy had a coercive force of 10.5 Oe at 75°F, and a B_{max} of 11.5 kilogauss and 19.3 kilogauss at 1200° and 1400°F, respectively. The stress rupture life at 1200°–1400°F was greater than the strongest high-temperature commercially available magnetic-structural alloy. Author

N68-27693*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPLORATORY INVESTIGATION OF NOBLE METAL COATINGS FOR CHROMIUM

S. J. Grisaffe Washington 1967 8 p ref Presented at the 13th Meeting of the Refractory Composites Working Group, Seattle, 18–20 Jul. 1967; sponsored by NASA and AF

(NASA-TM-X-52324) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Chromium, a body-centered cubic metal which exhibits a sharp temperature transition between ductile and brittle behavior, has a high solubility for nitrogen at high temperatures. In order to find a protective coating for chromium capable of stopping nitrogen ingression and minimizing oxidation at elevated temperatures, an experiment was conducted to explore the protection afforded by coatings of platinum, palladium, iridium, and rhenium. Details are given on the various tests conducted, in which metallographic observations, supplemented by a limited number of bend angle tests, were used to evaluate the protective ability of the metal coatings. Results are reported and summarized metallographically. It is concluded that the noble metals platinum and palladium are not satisfactory coatings for long time protection of chromium alloys from nitrogen embrittlement in air at 2200°F or higher. B.S.D.

N68-27729 Wisconsin Univ., Madison.

A STUDY OF THE CONDITION OF BORON IN ALPHA IRON BY INTERNAL FRICTION

Richard Ching-an Sun (Ph.D. Thesis) 1967 146 p

Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-524

Internal friction techniques were used as a tool to study the condition of boron in alpha iron. The studies were made on a low boron and a high boron alloy containing carbon and nitrogen as impurities. Three different peaks were observed during the course of investigation. Firstly, a peak observed at 312°K (frequency: 1 cps) was confirmed to be due to the presence of interstitial boron, in agreement with the result reported by Thomas and Leak. Secondly, a peak observed at 297°K (frequency: 1 cps) was attributed to the carbon relaxation in the vicinity of the grain boundaries. Thirdly, the peak observed at 260°K (frequency: 2.93 cps) was reported by Hayashi and Sugeno, but this peak proved to be unreproducible. Moreover, a decrease in the peak temperature for carbon relaxation in the vicinity of grain boundaries of carburized Ferrovac E and Ferrovac 1020 steel was also investigated and reported in the Appendix, which provided knowledge to confirm the source of the 297°K peak. Dissert. Abstr.

N68-27738 Oklahoma Univ., Norman.

PROTON RADIATION INDUCED BLISTERING OF ALUMINUM

Leonard Milacek (Ph.D. Thesis) 1967 95 p

Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-9491

Investigation of the effects of low energy proton irradiation of aluminum and gold samples demonstrated that protons in the energy range 7 to 450 keV could cause permanent damage to the materials. This damage is in the form of pitting and blistering of the metal surface. These observations are of significance to the application of these materials for thermal control surfaces in space flight applications. High purity aluminum exhibited surface pitting and blistering in the irradiated area. The proton radiation induced pitting and blistering phenomena have been studied using optical and electron microscopy. Attention was given to determine the influence of crystal orientation, surface preparation, material purity, substructure, and cold work on the manner of occurrence and appearance of blistering. Dissert. Abstr.

N68-27779 Dartmouth Coll., Hanover, N. H.

STRUCTURAL AND SOLIDIFICATION BEHAVIOR IN UNDERCOOLED Ga–In EUTECTIC ALLOY

John M. Lo (Ph.D. Thesis) 1967 121 p

Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-10469

Bulk samples of eutectic alloy, Ga–24.5% In, have been undercooled to investigate structural and solidification behavior. Thermal measurements on cooling and heating cycles have disclosed four principal modes of metastable phase transformations. On cooling below the eutectic temperature, the terminal In-rich phase precipitates. Nucleation and growth for the remaining Ga-enriched undercooled liquid follow the sequence: Ga I–In for mode A; metastable Ga_3In_2 and Ga I–In for mode B; metastable Ga II–Ga_3In_2, and Ga I–In for mode C; metastable Ga II–In, and Ga I–In for mode D. These phase transitions conform to Ostwald's rule of reaction in successive steps of free energy reduction from the unstable liquid to the most stable solid phase mixture Ga I–In. Heterogeneous nucleation involving the phases exhibits increasing catalytic potency as nucleating agents in the order: In, Ga_3In_2, Ga II, and Ga I. Dissert. Abstr.

N68-27785 Purdue Univ., Lafayette, Ind.

THE NATURE AND SIGNIFICANCE OF THE DISTRIBUTION OF HIGH-SPEED-STEEL TOOL LIFE

John Gilbert Wager (Ph.D. Thesis) 1967 248 p

Available from Univ. Microfilms: HC $11.25/MF $3.20 Order No. 67-10271

Experience has shown that variation in the life of cutting tools occurs when repeated tests are made using the same type of tool and work material and nominally constant cutting conditions. Although there are many instances in the literature where the range of life values is reported for small sets of tests made under such conditions, very little attention appears to have been given to the nature and possible causes of tool life variation based on several hundreds of tests under controlled conditions. The present work describes a new method of life testing for high-speed-steel tool material, using the criterion of complete failure of the cutting edge. By this method it is possible to impose many tests on the same tool piece and tubular workpiece. It has been named the corncob test because of the appearance of the length of square-section tool material after the completion of about 50 tests. Dissert. Abstr.

N68-27789 Syracuse Univ., N. Y.

INTERMETALLIC COMPOUNDS IN THE SYSTEMS Sr–Mg AND Ba–Mg

Charles Francis Miskell (Ph.D. Thesis) 1966 69 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-9311

The original purpose of this investigation was to remove some of the ambiguities in the strontium-magnesium diagram, particularly at the strontium-rich end. Many alloys of compositions between fifty weight percent strontium and pure strontium were studied by thermal analysis and X-ray powder diffraction methods. These studies verified the general outlines of published phase diagrams for this system but the complex X-ray patterns were difficult to interpret because of uncertainties regarding the number and compositions in intermediate phases in the system. Comparison of these X-ray patterns with patterns for barium–magnesium alloys of similar compositions was of little help. It became necessary to determine the natures of the compounds in these systems by X-ray diffraction study of single crystals isolated from selected alloys. The single crystal studies, supplemented by powder diffraction data have produced solutions for the structures of Sr_6Mg_{23}, Ba_6Mg_{23}, and $SrMg_4$. Dissert. Abstr.

N68-27811 Rensselaer Polytechnic Inst., Troy, N. Y.

A NEW APPROACH TO THE STUDY OF HOT-CRACKING IN FUSION WELDS

Carl Dean Lundin (Ph.D. Thesis) 1966 137 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-9287

The design and development of a new testing technique capable of evaluating the hot-cracking tendency of weldments is described. This technique, known as the VARESTRAINT (VAriable RESTRAINT) technique permits the evaluation of base-metal weldability as well as determining the influence of particular welding process and associated welding variables on hot-cracking. The VARESTRAINT technique provides a reproducible means for augmenting the normal shrinkage strains and thus simulates the large shrinkage strains characteristic of a highly restrained weldment in a small, inexpensive laboratory specimen. Of great importance is the fact that the augmented-strain concept permits the separation of the influence of metallurgical and mechanical variables on hot-cracking. Data is presented which shows that the VARESTRAINT technique provides a unique means for studying the mechanisms of hot-cracking. Dissert. Abstr.

N68-27822 Rensselaer Polytechnic Inst., Troy N. Y.

THE STUDY OF MECHANICAL VIBRATIONS ON THE NUCLEATION OF SUPERCOOLED METALS, PARTS 1 AND 2

James Joseph Frawley (Ph.D. Thesis) 1966 165 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-9278

Experiments were carried out to induce nucleation by applying vibrational energy to small specimens of liquid bismuth, tin, and bismuth-tin alloys having a large static supercooling. The results of this investigation showed that the vibrational amplitude at which nucleation was affected was dependent on the intensity of the mechanical vibration and less on the frequency, amount of static supercooling, and alloying elements present. In order for nucleation to occur the mecahnical vibrations must cause cavitation in the melt: This phenomenon is explained by high pressures causing the nucleation of materials which have a higher density after freezing, and rarefaction pulse causing the nucleation of materials which have a lower density after freezing. When the intensity of the sound field in the megacycle range was small, i.e., no cavitation was occurring in the melt, the amount of dynamic and static supercooling were the same if the amount of static supercooling was 90°C; however, if the amount of static supercooling was small, about 50°C, the amount of dynamic supercooling is greater than the static supercooling. The effects of vibrational energy on the final grain size showed that if the intensity of the applied sound field is not great enough to fragment the growing dendrites in a pure liquid metal no grain refinement is observed. Dissert. Abstr.

N68-27833 Michigan Univ., Ann Arbor.

DIFFUSION IN BINARY LIQUID METAL SYSTEMS

John Barnett Edwards (Ph.D. Thesis) 1966 343 p
Available from Univ. Microfilms: HC $15.55/MF $4.40 Order No. 67-8246

A new experimental technique was developed for measurement of diffusion coefficients in liquid metals. This technique involved the discharge of a liquid metal concentration cell in which diffusion in the cathode alloy was rate limiting. Diffusion coefficients were obtained from measurement of cell potential and discharge current. Diffusion coefficients have been measured for potassium in mercury, sodium in lead, and sodium in tin for a range of temperature and alloy compositions. The coefficients obtained were reproducible, internally consistent, and have values reasonable for diffusion in liquid metals. The probable error in the measurements was ±25% and this error was due primarily to uncertainties in the thermodynamic data available for evaluation of the cell potential. The reproducibility, however, was better than ±5% in all cases. Dissert. Abstr.

N68-27922# Archer-Daniels-Midland Co., Minneapolis, Minn.

GAS-CURED URETHANE RESIN SYSTEMS FOR SPACE STRUCTURES

W. McKillip, J. Lee, and R. French (Goodyear Aerospace Corp., Akron, Ohio) *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 89–103 (See N68-27917 16-32)

The feasibility of using urethane resin, a newly developed material, for rigidizing packageable, expandable structures after deployment in space was studied. Emphasized is the applicability of this material to 10 ft diameter parabolic solar collectors and four foot diameter by eight foot long cylinders. To determine the feasibility of urethane resin, the following interrelated problems were studied: contour accuracy; sealing of Airmat structure (a sealed fabric sandwich structure); mirror surface quality; bonding layer; and packaging. Results of these studies indicated that: (1) the vaporset resin rigidizing system has good potential for future use; (2) the solar collector concept developed and demonstrated is feasible and with refinement ultimately could be used in a space system; and (3) the resin system can seriously be considered for application to other structure types. S.C.W.

N68-27939# Air Force Cambridge Research Labs., Bedford, Mass.

REINFORCED BALLOON FILMS

Thomas W. Kelly *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 445–464 (See N68-27917 16-32)

Contemporary balloon flight problems related to available and soon to be available materials are discussed, and recently developed techniques for producing inexpensive reinforcing materials which may have applications beyond the field of balloon design are described. Emphasized are materials problems induced by the demand for balloon vehicles to carry heavier payloads to higher altitudes for longer durations. Materials problems and systems constraints of zero pressure balloons are considered. In view of inherent limitations of polyethylene construction material for balloons in the 4,000 pound payload range, and in response to the need for heavy payload flight, a new type of laminated balloon material was developed which provided extra strength for very heavy scientific payloads and maximum reliability for the flight of new and expensive equipment. However, although Mylar film bonded to a woven network of Dacron fibers proved to be superior balloon material, the high cost of scrim balloons greatly increased their use and to overcome this limitation, a program was initiated to lower the cost of scrim balloons through value engineering analyses of designs, materials, and production techniques. The most far reaching result of this program was the introduction of an entirely new family of balloon materials which substitutes a non-woven grid of reinforcing threads for the woven scrim fabric used in the conventional scrim laminate. A machine, designated the flying thread loom (FTL) was used to produce the nonwoven scrim. Principles of operation of the FTL are described, and the importance of this new technique in the development of a new family of FTL materials for balloon applications is discussed. S.C.W.

N68-27944# Archer-Daniels-Midland Co., Minneapolis, Minn.

WATER-EXTENDED POLYESTER RESIN (WEP) FOR LIMITED WAR SHELTER CONSTRUCTION

Robert H. Leitheiser, Richard J. Hellmer, and Edwin T. Clocker *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 551–568 (See N68-27917 16-32)
(Contract AF 33(615)-3519)

Reported is the development of a new material of construction designated WEP (water extended polyester resin), which is applicable in the rapid repair of bomb damaged runways. WEP is prepared by dispersing water in a polyester resin and rapidly curing the low viscosity product to a load bearing composite. WEP can be made to cure rapidly enough to be load bearing in less than ten minutes. Major advantages of the cured product WEP are: good logistics, structural strength, low cost, ease of use, fast cure; good chemical resistance, excellent fire resistance, and versatility. The favorable logistics, economics, and flame retardancy result from the ability to use 60, 70 and even higher percentages of water from locally available sources to extend the resin. Realizing that transportation is a major factor when considering a material for use in a bare base application, the logistics of WEP were compared with those of concrete and No. 2 pine. WEP was superior to wood and comparable to concrete if local aggregate was available but vastly superior to concrete if aggregate also had to be transported to the site. Ease of handling was also determined, and WEP was preferred to either concrete or wood because all the ingredients are easily pumpable liquids. Economically, WEP is significantly more expensive than concrete; however, it is competitive with wood, especially the better grades of wood. Proposed structural applications for WEP include storage shelters, maintenance hangers, and personnel housing in forward area tactical air bases. S.C.W.

N68-27961# Hughes Aircraft Co., Culver City, Calif. Materials Technology Dept.

AUTOMATIC CURING OF REINFORCED PLASTICS IN SPACE

S. Schwartz and L. B. Keller *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 707–736 refs (See N68-27917 16-32)

A review is made of a number of systems for automatically rigidizing expandable, fabric impregnated space structures. Space environment conditions are shown as usable for activation of polyester, polyurethane, epoxy and a new gelatin reversible system particularly well suited for space work. The gelatin system is described in detail, including impregnation and fabrication techniques and physical properties in comparison with conventional resin systems. Author

N68-28052# California Univ., Berkeley. Lawrence Radiation Lab.

ELECTRON RESONANCE STUDIES OF CRITICAL FLUCTUATIONS IN ANTIFERROMAGNETS

Jerome F. Siebert (Ph.D. Thesis) Mar. 1968 82 p refs
(Contract W-7405-ENG-48)
(UCRL-18119) CFSTI: HC$3.00/MF$0.65

Magnetic relaxation in the three antiferromagnets CsMnF$_3$, RbMnF$_3$, and KMnF$_3$ has been studied as a function of temperature, with special emphasis on the critical region just above T$_N$. The resonance fields in CsMnF$_3$ were measured as a function of temperature between 75 and 300°K with the field applied parallel and perpendicular to the c axis. The results were qualitatively consistent with the behavior and temperature dependence of the anisotropy field predicted by theory and determined from low-temperature torsion experiments. RbMnF$_3$ ($T_N \approx 82.5°K$) and KMnF$_3$ ($T_N \approx 88°K$) are low-anisotropy, cubic antiferromagnets, so that intrinsic spin processes should dominate the relaxation. In both crystals the linewidth remained constant as the temperature was lowered from room temperature through T$_N$. This result is inconsistent with existing theories of spin relaxation based on the conventional theory of critical fluctuations. Therefore, a critical review of these theories was made and some possible modifications are proposed. Author

N68-28060# Babcock and Wilcox Co., Lynchburg, Va.

CORROSION AND HYDRIDING OF ZIRCALOY Quarterly Technical Progress Report, Oct.–Dec. 1967

Feb. 1968 12 p
(Contract AT(30-1)-3765)
(BAW-3765-5; EURAEC-1951; QTPR-5) CFSTI: HC $3.00/MF $0.65

Corrosion and hydriding of Zircaloy under heat transfer conditions to determine the quantity of hydrogen absorbed during service, and mechanical property of hydrided Zircaloy to determine the effect of hydrogen on cladding properties are the objectives of the testing. The first phase of the heat transfer corrosion and hydriding tests was previously completed. Seven specimen groups were exposed in the loop and autoclave under heat transfer and isothermal conditions simulating a pressurized water reactor environment. The exposure times varied from 360 hours to 4330 hours. The second loop test phase was initiated and modification of the water chemistry to the chemical shim environment was completed. The new test environment contains 13,000 ppM boric acid, 4 to 6 ppM potassium hydroxide, and 0.5 ppM lithium as the hydroxide. A specimen inventory in the loop for the chemical shim test was made. After about 475 hours of operation under chemical shim conditions, a previously exposed Zircaloy-2 specimen failed. The volume of data accumulated is being used to ascertain the cause of failure of the one specimen. NSA

N68-28090# Radio Corp. of America, Princeton, N. J. RCA Labs.

IMPROVED COMPATIBLE MATERIALS FOR THERMOELECTRIC POWER GENERATION Semiannual Report

J. P. Dismukes, I. Kudman, and H. Moss Feb. 1968 45 p refs
(Contract AT(30-1)-3886)
(NYO-3886-1) CFSTI: HC$3.00/MF$0.65

The first system investigated for improved p-type material was the PbTe–GeTe system, since n-type material in this system was known to give superior properties. A series of alloys containing 1 to 15% GeTe was prepared in this system with various p-type dopants, but upon life testing, the electrical properties were found to be unstable, which could be attributed to an insufficient

equilibrium solubility of the dopants. Therefore, work on this system has been terminated. In the next system investigated, PbTe–PbSe, the solubility of sodium was found to be enhanced by the addition of PbSe. The figure of merit of the 95 mole % PbTe–5 mole % PbSe composition doped with a 0.7 mole % Na was found to be 30% greater at elevated temperatures than that of p-type PbTe. Life tests at 400°C have shown no change in resistivity after 2000 hours for 95% PbTe–5% PbSe, but small changes were observed for samples containing 10 and 15% PbSe. Therefore, the 95% PbTe–5% PbSe composition appears to be the optimum.
Author (NSA)

N68-28106# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.

AN EVALUATION OF W-Re PRODUCED BY BOTH ARC-MELTING AND POWDER METALLURGY Topical Report, 1 Sep. 1964–31 Jul. 1967

R. R. Lowery and G. Asai Jan. 1968 74 p
(Contract AT(11-1)-599)
(USBM-RC-1274) CFSTI: HC $3.00/MF $0.65

An evaluation of tungsten-25 weight percent rhenium alloy processed by both powder-metallurgy (PM) and arc-melting (AM) techniques was accomplished. Methods of consolidation, fabrication, and testing are discussed. Extrusion was used as the primary breakdown process for the PM and AM billets. Sheet bar extrusions, 2.54 cm by 5.08 cm in cross section, were conditioned and rolled to 0.15 cm-thick sheet. Bend tests were made upon the sheet to determine ductile-to-brittle transition temperatures (DBTT). The AM sheet was superior to PM sheet in ductility. Recrystallized AM sheet exhibited a DBTT of 185°C in a 4t bend, whereas, the corresponding temperature for PM sheet was 380°C. Tensile properties of recrystallized AM sheet were determined from 25 to 2,500°C. Creep-rupture data at 1,650°C and 2,200°C were collected up to 1,000 hours. The PM sheet was inferior to the AM sheet in both ductility and rupture life. An examination was made of electron-beam weld zones in both sheet products which indicated porosity was more extensive in the weld zones of the PM sheet. Electron microscopy was used to view fractures in both bend and weld specimens. Porosity was found in the PM sheet in both cases.
Author (NSA)

N68-28121# Department of Supply, Melbourne (Australia). Aeronautical Research Labs.

THE INFLUENCE OF A CARBIDE DISPERSION ON THE RECRYSTALLIZATION BEHAVIOUR OF CHROMIUM

N. E. Ryan Mar. 1967 21 p refs
(ARL/MET-64)

Finely dispersed particles of tantalum carbide retard recovery and recrystallization in chromium, although transmission electron microscopy indicates that the mechanism of recrystallization is unchanged. This retardation is attributed to the absence of any marked lattice misorientations in the wrought structure of the dispersion-hardened alloy. An intractable dislocation sub-structure is produced in this material by the initiation of slip on many independent systems and by an increase in the frequency of cross slip. In addition, the carbide particles interfere with the rearrangement of the dislocations during recovery and recrystallization and restrict the movement of sub-grain and grain boundaries. Author

N68-28131# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.

FATIGUE-CRACK GROWTH RATE STUDIES OF NUCLEAR PRESSURE-VESSEL STEELS

D. F. Mowbray and W. R. Andrews 25 Aug. 1967 23 p refs
(Contract W-31-109-ENG-52)
(KAPL-3383) CFSTI: HC $3.00/MF $0.65

Fatigue-crack growth rates were determined for ASTM A302-B and A508-2 steels in two characteristic plate and forging directions. Two different plate-specimen geometries were investigated. One specimen type had cracks growing from a centrally located through-the-thickness hole (through-crack specimen); the second specimen type had a part-through crack of semielliptical shape (surface-crack specimen). The loading cycle in all the tests was zero-to-tension at various constant gross-section stress levels, and the crack growth rates ranged from 10^{-5} to 10^{-3} in./cycle. Data obtained from the two specimen types were correlated upon the hypothesis that the crack extension per cycle was proportional to a positive power of the stress intensity factor. This hypothesis produced an excellent correlation of the data obtained from the through-crack specimens in both test directions. In addition, the rate of crack extension through the plate thickness of the surface-crack specimens was successfully correlated with data from through-crack specimens. Author (NSA)

N68-28150# Aeronautical Research Labs., Melbourne (Australia).

THE EFFECT OF ROOM-TEMPERATURE PRESTRAIN ON THE TENSILE PROPERTIES OF THE INTERMETALLIC COMPOUND NiTi IN THE TEMPERATURE RANGE 150°–370°C

A. Ball, S. G. Bergersen, and M. M. Hutchison May 1967 16 p refs
(ARL-MET-50) CFSTI: HC $3.00/MF $0.65

A martensitic transformation of the cubic compound NiTi by room-temperature deformation is presented. The propagation of a band of transformation along the tensile specimen during the initial deformation generates an exceptionally high density of dislocations. These dislocations remain in the material heated above the martensitic reversion temperature and, as a result, specimens treated in this manner have a much higher flow stress in the temperature range 150°–370°C, than does annealed material. Author

N68-28164# Atomic Weapons Research Establishment, Aldermaston (England).

THE PRODUCTION OF FINE METAL POWDERS USING GRINDING AIDS

R. A. Knight and C. A. Calow Apr. 1968 13 p refs
(AWRE-O-39/68) CFSTI: HC $3.00/MF $0.65

Nickel-chromium alloy powder of −200 mesh particle size, with Ni:Cr ratio by weight of 80:20, was reduced in particle size by adding various grinding aids and surfactant to the ethanol grinding fluid. The grinding aids were sodium pyrophosphate, ammonium benzoate, ammonium bicarbonate, and aluminum chloride; stearic acid was the surfactant; and dry ball milling of the powder resulted in gross agglomeration of the particles after 1/2 hour. While the various grinding aids could reduce particle size of the Ni-Cr powder to 2 to 4 μm, the most efficient grinding aids were those with high valency ions and complex anions. M.W.R.

N68-28165# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

ELECTRICAL DISCHARGE MACHINING COVERING THE PERIOD 1960 TO 1967

A. R. C. Whiteman, comp. and R. Leadbetter, comp. Feb. 1968 12 p refs
(AERE-BIB-159) CFSTI: HC $3.00/MF $0.65

A bibliography, presented alphabetically by author, deals with electrical discharge machining technology. Sources of the references are: (1) American Society of Metals Review publications, 1960–68; (2) Engineering Index, 1958–66; (3) Metallurgical Abstracts, 1959–67; (4) Science Abstracts—B. Electrical Engineering Abstracts, 1959–67; and (5) Scientific and Technical Aerospace Reports, 1965–67. M.W.R.

N68-28189# Aeronautical Research Labs., Melbourne (Australia).
DEFORMATION SUBSTRUCTURE AND SUSCEPTIBILITY TO INTERGRANULAR STRESS CORROSION CRACKING IN AN ALUMINIUM ALLOY
H. A. Holl Oct. 1966 18 p refs
(ARL/MET-45) CFSTI: HC$3.00/MF$0.65

The dislocation arrangements in a deformed aluminum zinc-magnesium-copper alloy aged to various states of susceptibility to stress corrosion cracking have been examined by transmission electron microscopy. Material in a highly susceptible condition deforms in a characteristic manner; slip is concentrated in well defined bands and dislocations show a marked tendency to remain on their original slip planes. In material exhibiting a low susceptibility, restricted slip does not occur and dislocations form uniformly distributed tangles. These results are interpreted in terms of existing models for intergranular stress corrosion cracking. It is concluded that when this alloy is aged to contain G.P. zones or coherent precipitates it will be highly susceptible to stress corrosion cracking, whereas when aged to contain non-coherent precipitates the alloy will be highly resistant. Author

N68-28199# Aeronautical Research Labs., Melbourne (Australia).
THE EFFECT OF THE ANION AND SOLUTION PH ON ANODIC PROCESSES AND CORROSION OF IRON
K. F. Lorking Oct. 1966 10 p refs
(ARL/MET-48) CFSTI: HC$3.00/MF$0.65

The corrosion of iron has been investigated in five decinormal solutions over the pH range 1.6–13.3 and has been found to depend on both the nature of the anion and the pH of the solution. The electrochemistry of iron was studied in these solutions using a potentiostat technique. Comparison of results of electrochemical and corrosion tests showed that the electrochemical technique could not be used to determine whether or not a solution was corrosive. Analysis of results showed that, on oxide-free iron, the anion has a specific effect on ferrous-ion formation and passivation of the iron surface. Author

N68-28204# Battelle Memorial Inst., Columbus, Ohio.
EFFECTS OF LARGE FAST FLUENCES ON MECHANICAL PROPERTIES OF TYPE 347 STAINLESS STEEL AND ALUMINUM
Mihkel Kangilaski, Frederic R. Shober, John A. De Mastry, and John E. Gates 27 Mar. 1968 36 p refs
(Contract W-7405-ENG-92)
(BMI-1834) CFSTI: HC$3.00/MF$0.65

Changes in mechanical properties of type 347 stainless steel, irradiated at about 50°C, were determined after fast fluences (>1 MeV) from 5.5×10^{21} to 21×10^{21} n/cm^2. Tensile tests were performed at room temperature, 316, and 750°C. At room temperature and 316°C the yield and tensile strengths are increased, with the ratio of yield strength to ultimate strength being nearly unity. Increases in strength saturated after a fast fluence of 5.5×10^{21} n/cm^2. A decrease of room-temperature ductility saturated after a fast fluence of 5.5×10^{21} n/cm^2; however, at 316°C ductility decreased up to 21×10^{21} n/cm^2. Annealing at 982°C for 1 hr completely restored preirradiation mechanical properties at room temperature and 316°C, except for a 10% decrease in ductility. At room temperature and 316°C, fracture is transgranular, while at 750°C fracture is integranular. At 750°C after a fast fluence of 21×10^{21} n/cm^2, elongation was reduced from the normal 26% to 0.5%. Annealing for 1 hr at 982 or 1350°C decreased strength and did not improve the as-irradiated ductility. Author (NSA)

N68-28208# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
A SOLUBILITY INVESTIGATION OF TIN IN NIOBIUM IN NIOBIUM–10 PERCENT TIN ALLOYS [PROBA SPRAWDZENIA ZAKRESU ROZPUSZCZALNOSCI Sn W Nb NA PRZYKLADZIE STOPU Nb–10 PERCENT Sn]
W. Rutkowski and Z. Horubala 1967 19 p refs In POLISH; ENGLISH summary
(INR-877/XIV/PS)

Metallography, radiography, and hardness were tested on alloys containing Nb+10% Sn. The specimens were produced from powders by powder metallurgy. The alloy, a solid solution of Sn in Nb is investigated. The experiment results are in accord with previous investigations on Nb-Sn alloys and their phase-diagrams. Author (NSA)

N68-28209# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
DILATOMETRIC INVESTIGATIONS OF THE TRANSFORMATION $\beta\rightarrow\alpha$ IN U–0.4 W/O Cr ALLOY [BADANIA DILATOMETRYCZNE KINETYKI PRZEMIANY $\beta\rightarrow\alpha$ W STOPIE U–0,4 PERCENT CIEZ. Cr]
A. Hofman 1967 19 p refs In POLISH; ENGLISH summary
(INR-874/XIV/PS)

Isothermal transformation $\beta\rightarrow\alpha$ of U–0.4 wt % Cr alloy at 640 to 400°C was investigated by the dilatometric method. The known kinetic equations were used for quantitative determination. The C-curve for the transformation was obtained. Activation energy for the process was calculated. The possibility of the existence of two C-curves at 640 to 400°C has been discussed. Author (NSA)

N68-28212# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
METALLOGRAPHIC AND X-RAY INVESTIGATIONS OF THE ISOTHERMAL TRANSFORMATION $\beta\rightarrow\alpha$ IN U–0.4 W/O Cr ALLOY [BADANIA METALOGRAFICZNE I RENTGENOGRAFICZNE STRUKTUR PRZEMIANY IZOTERMICZNEJ $\beta\rightarrow\alpha$ W STOPIE U-CR 0,4 PERCENT CIEZ. CR]
Andrze Hofman 1967 18 p In POLISH; ENGLISH summary
(INR-873/XIV/PS)

The isothermal phase transformation $\beta\rightarrow\alpha$ of U–0.4 wt % Cr alloy at 630 to 400°C was investigated by means of metallography and x-ray analysis. The results are in agreement with previous suggestion, based on the dilatometric measurements that there are two C-curves (in the temperature range taken into account). A suggestion on the explanation of the existence of two transformation mechanisms $\beta\rightarrow\alpha$ for upper and lower C-curves is given. Author (NSA)

N68-28276# United Kingdom Atomic Energy Authority, Harwell (England). Electronics and Applied Physics Div.
GALLIUM ARSENIDE A Review
J. Frey Mar. 1968 18 p refs
(AERE-R-5757) CFSTI: HC$3.00/MF$0.65

Properties and applications of gallium arsenide are reviewed, and current ion implantation studies are discussed. Band structure, transport properties, and physical properties are included; and attention is given to semi-insulation GaAs, crystal growth, impurities, and other aspects of material preparation and availability. Passivation and contacts are mentioned, and hazards of arsenic and gallium arsenide are noted. Applications included are bipolar and field effect transistors; injection lasers; and light emitting, Schottky barrier, tunnel and varactor diodes. M.W.R.

N68-28288# MSA Research Corp., Evans City, Pa.

EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. TOPICAL REPORT NO. 9. ANALYSIS OF HIGH OXYGEN AND HIGH CARBON COLD TRAPS

S. J. Rodgers, C. A. Palladino, and T. J. Wildeman Dec. 1967 73 p refs
(Contract AT(11-1)-765)
(MSAR-67-203) CFSTI: HC $3.00/MF $0.65

Two cold traps were removed from operational loops and the contents were analyzed for O_2, C, N_2, H_2 carbon compounds, particle size and metallic impurities. Cold Trap I–C had operated for 1400 hours, and Cold Trap II–O_2 had operated for 2300 hours. Loop I–C had operated with a high carbon environment where part of the main-stream flow was passed through a bed of graphite rods at 1200°F. Loop II–O_2 had operated with a high oxygen environment with the cold trap being operated at 700°F to provide oxygen concentration of $\approx$300 ppM O_2. The oxide was concentrated in the space below the mesh and in the first few inches of the mesh. Cold Trap I–C which operated at 250°F effectively removed hydrogen, while Cold Trap II–O_2 which operated at 700°F did not remove hydrogen. Carbon was found in both cold traps. Cold Trap I–C contained 0.05 pounds of carbon, and Cold Trap II–O_2 contained 0.01 pounds of carbon. It appeared that mesh must be used in a cold trap if carbon is to be removed effectively. Carbon dioxide, C_2H_2 and HCN were found in both traps at significant levels. Traces of methane, ethane, ethylene, carbonyl sulfide, hydrogen sulfide, cyanogen and oxymonocyanogen were found, also. Iron ranging to 1% was found in Cold Trap I–C; maximum iron concentration in Cold Trap II–O_2 was $\approx$0.5%. On the basis of the relative quantities of CO_2, C_2H_2 and HCN detected during analysis, it is assumed that Na_2C_2 or some acetylene-producing compound, such as a carbonyl, is responsible for carburization of austenitic steels. Author (NSA)

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N68-26968# Aberdeen Proving Ground, Md. Army Coating and Chemical Lab.

OXIRANE-POLYESTER RESIN SYSTEM IN AIR DRYING GLOSS ENAMELS Final Report

Joseph H. Thompson Apr. 1968 135 p refs
(CCL-248; AD-668647)

A two-component oxirane-polyester resin system was evaluated for use in exterior, air drying, gloss enamels. Enamels prepared from this resin system were more resistant than current specification alkyd enamels to acids, alkali, hydraulic fluids, abrasive wear, water immersion and yellowing upon aging. They also exhibited improved gloss, appearance and hardness, but were less flexible than the alkyd enamels. After one year exposure in a temperature climate, the experimental enamels had better gloss retention; in a tropical environment they had poorer gloss retention. After two years exposure in both environments gloss retention of most of the enamels was comparable and remained so for exposure periods up to four years. At both exposure sites the rates of color change and chalking were equal. Author (TAB)

N68-27022# Picatinny Arsenal, Dover, N. J. Explosives Lab.

ANALYSIS OF THE SENSITIVITY OF EXPLOSIVE MATERIALS TO INITIATION BY IMPACT. VARIOUS STATISTICAL METHODS

Peter J. Kemmey Apr. 1968 15 p refs
(PA-TM-1812; AD-668675)

Various statistical methods are presented for the analysis of explosive sensitivity test data. The Karber, Probit, chi-squared, and Bruceton methods are presented. Criteria are developed for choice of the most suitable methods for reaching decisions about relative changes in, absolute values of, and predictability of the sensitivity of explosive materials. Author (TAB)

N68-27045# Army Natick Labs., Mass. Clothing and Organic Materials Lab.

THE APPLICATION OF THE CONCEPT OF RELIABILITY TO TEXTILE PRODUCTS

Stephen J. Kennedy and Louis I. Weiner Sep. 1967 30 p refs
Its TS-153
(TR-68-23-CM; AD-668907)

In common with many other natural products, the nature and use patterns of items of textile clothing and equipage are such that data for formulating exact models for predicting reliability in terms of mission times and mean-times-between failures are not easily obtainable. However, reliability analysis based upon the probability of determining whether or not a given characteristic falls within the use requirements for the material or material system has been found feasible in many cases. A considerable amount of such data is available and is presented in the report to suggest possible approaches for reliability analysis studies. Some of the inherent problems in applying reliability analysis to a broad range of textile end items are examined and discussed. Author (TAB)

N68-27087*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.

DEVELOPMENT AND OPTIMIZATION OF PYRRONE POLYMERS, JUNE 1966–JUNE 1967

L. E. Karre, L. B. Keller, B. G. Kimmel, and L. J. Miller Jun. 1967 74 p refs
(Contract NAS1-6287)
(NASA-CR-66542; P67-203) CFSTI: HC $3.00/MF $0.65 CSCL 11I

This report describes those polymers formed from the condensation reaction of aromatic dianhydrides with aromatic tetraamines in various solvents. In Phase I, the primary efforts were directed towards the synthesis and characterization of the polymer formed from the condensation of pyromellitic dianhydride (PMDA) with diaminobenzidine (DAB) in polar solvents, and the subsequent preparation and testing of fabricated articles. In Phase II, primary efforts were directed toward the synthesis, characterization, and subsequent fabrication of the polymer formed from the condensation of benzophenone tetracarboxylic dianhydride (BTDA) with diaminobenzidine (DAB) in the esterifying solvent ethylene glycol (EG). Fiberglass laminates formed with the Phase II polymer had room temperature flexural strengths above 70,000 psi and moduli on the order of 5×10^6 psi. This improvement is attributed to several factors including the elimination of the ionic interaction between the polymer and polar solvents, the plasticizing effect of internally bound ethylene glycol, and the inherent increased flexibility of the additional BTDA single bond. Pyrrone polymers synthesized in ethylene glycol are tractable and laminates based on these polymers show promise as a high temperature resistant structural material. Author

N68-27086*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

DEVELOPMENT OF SILOXANE-CONTAINING EPOXY POLYMERS FOR ELECTRICAL CIRCUIT EMBEDMENT APPLICATIONS

William J. Patterson 26 Jan. 1968 44 p refs
(NASA-TM-X-53698) CFSTI: HC$3.00/MF$0.65 CSCL 11I

This report describes the synthesis of seven epoxy polymer precursors which contain the siloxane linkage in varying structural arrangements, and the polymerization of these materials with aromatic diamines. The polymers prepared from such intermediates have utility as embedment compounds for electrical circuits. Seven epoxy intermediates were prepared, characterized, and subsequently polymerized into solid, thermosetting materials for which dielectric property data were obtained. Dielectric constants as low as 3.1 at one kilocycle were measured for polymers prepared from polymerization of 1,9-bis (p-(2,3-epoxypropyl) phenyl) decamethylpentasiloxane with 1,4-bis (p-aminophenoxy) tetramethyldisiloxane, whereas polymers derived from 1,4-bis ((*p*-(2,3-epoxypropyl) phenyldimethylsiloxy) dimethylsilyl) benzene and the same diamine were characterized by slightly higher dielectric constants and a high degree of toughness. Author

N68-27093# Washington Univ., St. Louis, Mo.
INVARIANT PROPERTIES OF COMPOSITE MATERIALS Technical Report, May–Aug. 1967
Stephen W. Tsai and Nicholas J. Pagano (AF Mater. Lab., Wright-Patterson AFB, Ohio) Wright-Patterson AFB, Ohio AF Mater. Lab. Mar. 1968 33 p refs
(Contract N00014-67-C-0218)
(AFML-TR-67-349; AD-668761)

Invariant properties of the elastic coefficient matrices of laminated composite plates are presented. The use of these invariants in materials evaluation and design optimization is discussed. Simple formulas, based upon micromechanics results, are derived for the invariants in terms of constituent material properties. Author (TAB)

N68-27241# Polytechnic Inst. of Brooklyn, N. Y. Chemistry Dept.
NEW POLYMERS TO PROTECT SPACE VEHICLES Final Report
Herman F. Mark, Dean F. R. Eirich, and Jeurgen Fock Oct. 1967 28 p
(Contract DA-31-124-ARO(D)-278; ARPA Order 553; Proj. Defender)
(PIBMRI-1385-67; AROD-5280:1-RT; AD-665442)

The synthesis and the characterization of new polymeric systems to be used as protective coatings for space vehicles is described. Particular emphasis is placed on ablators which have low irradiation and particle emissivity under the conditions of typical reentry of a space vehicle into the atmosphere. Crosslinking by ionizing radiation in carbon black filled Kel-F and Teflon was established by mechanical and thermoanalytical methods. Polyaromatic systems such as polyphenylene, methylated poly-phenylene, poly benzyl poly-p-xylylene, furthermore phenolic resins and a styrene-divinyl benzene copolymer were synthesized and investigated by thermogravimetric analysis. In addition Pluton impregnated with polyvinyl fluoride or crosslinked polystyrene was investigated. As a fourth approach towards new ablative materials, the synthesis of aromatic fluorocarbon and silicon type ladder polymers was initiated. The research on carbon-filled Teflon indicates a considerable improvement in heat shielding with polymeric ablators in terms of better mechanical properties and lower weight-to-heat dissipation ratios. Author (TAB)

N68-27315# Naval Research Labs., Washington, D. C.
TOUGHNESS IN PLASTICS BASED ON FRACTURE SURFACE APPEARANCE
Herschel L. Smith, Joseph A. Kies, and Austin B. J. Clark Mar. 1968 14 p refs
(NRL-MEMO-1863; AD-669112)

Relationships between fracture toughness and fracture surface appearance in plastic materials were studied and reported on a number of years ago. The report recalls such studies in the light of renewed interest in stretched transparent plastics and shows the relationship which exists between fracture toughness and fracture appearance. Author (TAB)

N68-27316# Johns-Manville Research Center, Manville, N. J.
DEVELOPMENT OF 400 TO 1800°F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. PHASE 1, VOLUME 1 Final Report
2 Oct. 1967 146 p
(Contract AT(30-1)-3633)
(ALO-3633-7, V. 1) CFSTI: HC$3.00/MF$0.65

Three MIN–K formulations were developed and evaluated for lead–telluride and silicon–germanium radioisotope thermoelectric generator service. Each formulation has certain optimum characteristics which govern its use, such as intricate service adjacent to lead–telluride elements, bulk load-bearing service to 1400°F, or non-load-bearing service to 1800°F. All three formulations were designed to have minimum outgassing characteristics. ASTROQUARTZ, DYNAQUARTZ, Irish REFRASIL, and MICROQUARTZ refractory fibers were also found suitable for service adjacent to silicon–germanium thermoelectric elements. Similarly, GLASROCK No. 25, a silica foam, had the best combination of thermal conductivity and compression resistance characteristics of the materials evaluated for load-bearing service at 1800°F. Author (NSA)

N68-27317# Johns-Manville Research Center, Manville, N. J.
DEVELOPMENT OF 400 TO 1800°F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. PHASE 1, VOLUME 2: APPENDIX A Final Report
J. O. Collins 2 Oct. 1967 170 p refs Prepared in cooperation with Martin Co., Baltimore
(Contract AT(30-1)-3633)
(ALO-3633-7, V. 2) CFSTI: HC$3.00/MF$0.65

Thermoelectric materials (2N, 2P, 3N, and 3P) were exposed to experimental insulation formulations Min–K 1999 and Min–K 2002 in an argon environment at 1000°F for a period of 2000 hours and changes in room temperature resistivity and open circuit voltage were measured at 500 hour intervals. Initial property values were compared with measurements made after each exposure interval and materials in contact with the test insulation material were compared with similar materials separated from the insulation for each exposure condition. Statistical techniques were employed in evaluating the data to the extent that limitations in sample size permitted. A complete compilation of all data is included and each conclusion may be directly traced to basic data. A thorough description of testing techniques and apparatus is also included. Author (NSA)

N68-27327# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
POLYURETHANE COATINGS FOR RAIN EROSION PROTECTION Technical Report, Jun. 1966–May 1967
George F. Schmitt, Jr. Mar. 1968 31 p refs
(AFML-TR-67-355; AD-669058)

Advancements in polyurethane coatings for subsonic rain erosion protection of metallic and plastic laminate substrates are described. Polyurethane coatings have been developed which offer protection for up to two hours at 500 MPH in two inches per hour simulated rainfall on a whirling arm apparatus; by comparison the specification neoprene coating lasts five to eight minutes under the same conditions. Flight tests on an F-100 aircraft and a UH-1 helicopter flying in heavy rain have confirmed the protectiveness of the coatings. Experimental studies of polyurethane have indicated that

a low modulus vehicle with good tensile strength and elongation yields the most erosion resistant coatings. Whirling arm evaluations, abrasion data, and hysteresis measurements have proven vital in determining these factors. Microwave power transmission tests have indicated 94 to 96 percent transmission for polyurethane coatings as compared to 90 percent for the neoprene coatings.
Author (TAB)

N68-27342# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
A REVIEW OF RESEARCH IN MICROMECHANICS OF COMPOSITE MEDIA, JULY–SEPTEMBER 1967
Nicholas J. Pagano and Stephen W. Tsai Mar. 1968 20 p refs
(AFML-TR-67-348; AD-669059)

The report consists of a review of the progress of research in micromechanics of composite media. Emphasis is placed on the analyses employing the principles of the theory of elasticity since existing works using strength-of-materials approaches have been superseded. It is not implied that the theory of elasticity is a Panacea; it is, however, the only self-consistent theory being used in the determination of composite moduli. The approximations employed in this theory regarding bonding, uniformity, and material response are also made in the less rigorous approaches.
Author (TAB)

N68-27363# American Meteorological Society, Boston, Mass.
STUDIES OF THE CRYSTALLOGRAPHY OF Al_2O_3 [ISSLEDOVANIIA PO KRISTALLOGRAFII Al_2O_3]
Bedford, Mass. AFCRL Mar. 1968 296 p refs Transl. into ENGLISH from Sb. Statei, Perevedennykh Iz Tr. Inst. Kristallogr. Akad. Nauk SSSR (USSR), no. 8, 1953
(Contract AF 19(628)-3880)
(T-RC-25; AD-669039)

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17. INFLUENCE OF CRYSTALLOGRAPHIC ORIENTATION ON RUBY WORKABILITY M. G. Bogdanovich p 263–272 (See N68-27380 16-15)

N68-27372# American Meteorological Society, Boston, Mass.
RESULTS OF OPTICAL STUDY OF THE MECHANICAL PROPERTIES OF SYNTHETIC CORUNDUM
M. V. Klassen-Nekliudova *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 135–165 refs (See N68-27363 16-18)

Optical studies were conducted to determine the inhomogeneity of corundum single crystals, the nature of the inhomogeneities, and their effects on the physical and chemical properties of corundum and on the various technological operations involved in synthesis and processing. The crystallization process is examined, and it is found that internal stresses produced in a corundum boule by its nonuniform cooling may cause a residual plastic deformation. Other results show: (1) Inhomogeneities such as residual volume stresses, plastic deformation bands, and mosaic structure have a marked effect on its mechanical properties. (2) Twinning may appear in boules at lower temperatures than do slip bands. (3) Plastic deformation bands and mosaic structure slightly increase the strength of corundum in some stress conditions; in others, they cause brittle fracture of small blanks and workpieces during processing. (4) Boules with mosaic structure are encountered much less frequently than boules with plastic deformation bands.
M.G.J.

N68-27374# American Meteorological Society, Boston, Mass.
THE OPTICAL ANOMALIES OF CORUNDUM AND THEIR RELATION TO ELASTIC STRESSES
N. Iu. Ikornikova *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 172–188 refs (See N68-27363 16-18)

A possible explanation is proposed for the polariscopic patterns that result from residual elastic stresses in synthetic corundum crystals, and a polariscopic method is described for studying elastic stress in optically isotropic materials such as amorphic substances and cubic crystals. Details are given on an experiment which was conducted to reproduce the pattern of the elastically stressed state of a corundum crystal and to determine the qualitative piezo-optical characteristic for a cross section perpendicular to the optic axis of the crystal. This established that the position of the plane of the optic axes, as determined at various points of an isotropic cross section of the corundum, usually is roughly perpendicular to the direction of the compressive force. Other findings indicate: (1) The optical anomalies of corundum observable along the optic axis of a crystal in polarized light are related to residual elastic stresses. (2) The optical properties of an unstressed corundum crystal are characterized by a spheroid, while those of a stressed corundum crystal are characterized by a biaxial ellipsoid.
M.G.J.

N68-27375# American Meteorological Society, Boston, Mass.
OPTICAL ANOMALIES CAUSED BY CORUNDUM INHOMOGENEITIES

N. Iu. Ikornikova and G. E. Tomilovskii *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 189–208 refs (See N68-27363 16-18)

An overview is presented on polarized light studies of corundum boules, half-boules, rods, plates, blanks, and watch jewels. As corundum exhibits both residual volume stresses and residual stresses related to slip planes with individual mosaic blocks, the optical anomalies are divided into three groups, distinguished externally by the nature of the distribution of anomalies in a crystal. These are the anomalies caused by residual volume stresses and by plastic deformation, and the anomalies that accompany mosaic structure in the crystal. Each group is examined in detail. It was found that residual volume stresses are removed in sawing and fracturing of the crystal in proportion to the reduction in size of the blank. However, residual local stresses related to the presence of plastic deformation and mosaic structure in the crystal persist after the samples are cut. M.G.J.

N68-27376# American Meteorological Society, Boston, Mass.

SYNTHETIC CORUNDUM BOULE STRUCTURE AS A FUNCTION OF CRYSTALLOGRAPHIC GROWTH ORIENTATION

A. V. Beliustin *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 209–221 refs (See N68-27363 16-18)

The quality and internal structure of boules as a function of their orientation are considered, and a relation is deduced between the output of high quality crystals and the angle of inclination of the optic axis of the boules with respect to their geometric axis. It was concluded: (1) Crystallographic orientation is the determining factor in the inhomogeneity of the inner structure of corundum boules. (2) Slips in corundum always follow orientations contained in prismatic (1120) planes, thus permitting optical determination of the position of the symmetry planes and twofold axes in the crystal if slip traces are present. (3) Amplitudes of plastic deformations in crystals will be small if the angle between the optic axis and the geometric axis is small. (4) Because the amplitude of the plastic deformations, the fineness of the mosaic structure, and the associated internal stresses depend on the crystallographic orientation of the boule, optimum boule growth occurs when the angle between the optic and the geometric axes is about 60° to 65°, and when the position of the twofold axes coincides with a parting plane. M.G.J.

N68-27377# American Meteorological Society, Boston, Mass.

TYPES OF SYNTHETIC CORUNDUM BOULES

N. Iu. Ikornikova *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 222–236 refs (See N68-27363 16-18)

The most frequently encountered types of structural inhomogeneities in corundum boules are described, and individual groups of boules are classified and defined. These include boules showing a predominance of inhomogeneities caused by volume stresses, plastic deformation, and mosaic structure, or by a combination of these factors. Seven main basic types of boules that differ in the forms of the inhomogeneities in the structure of corundum crystals and in the combinations of these forms are discussed. It was also found: (1) The comparative amount of the residual volume stresses in individual boules can be determined by the value of the maximum angle between the optic axes of a given crystal. (2) The distribution of regions with different forms of inhomogeneities in the boule may be used to determine whether various parts of the boule grew and cooled under identical or different conditions. (3) The pattern of boules examined in parallel light are related to their orientation. The angles between the optic and geometric axes of mosaic structure boules are usually less than those of homogeneous but plastically deformed boules. M.G.J.

N68-27378# American Meteorological Society, Boston, Mass.

OPTICAL AND X-RAY STUDY OF THE PARTING PLANES OF SYNTHETIC CORUNDUM

Z. M. Pigolina and V. V. Sviatukhin *In its* Studies of the Cryst. of Al_2O_3 Mar. 1968 p 237–252 refs (See N68-27363 16-18)

The connection between the orientation of developing parting planes and the symmetry elements of the crystal is examined. The surfaces formed by the parting of the ruby boules are identified as smooth–glassy, coarse–wavy, conchoidal, and hackly, which are observed in cases where the fracture does not coincide with a crystallographic plane. Mirror-like fractures are regarded as cleavage planes. Optical and x-ray methods for studying the parting planes are discussed. The data indicate: (1) The surfaces of a smooth mirror-like fracture and of a mirror-like fracture with hatching follow the (1120) or (1010) faces of a prism. A pronounced mirror-like fracture follows the basal plane (0001). (2) The surfaces of mirror-like fractures with hatching running in two directions that intersect at an acute angle coincide with the (1012) faces of a rhombohedron and (1214) faces of a dipyramid. A fracture with mirror-like areas and with hatching running in two directions, one of which is perpendicular to the geometric axis of the boule, also follows the (1214) faces of a dipyramid. (3) Fractures most commonly encountered in mechanical processing of corundum follow rhombohedron and dipyramid faces. M.G.J.

N68-27394# Army Natick Labs., Mass. Clothing and Organic Materials Lab.

STRENGTH LOSSES IN NYLON PARACHUTE MATERIALS WITH TIME, EXPOSURE, AND USE

Frank Figucia, Jr. and Richard D. Wells Mar. 1968 99 p refs
Its TS-156
(TR-68-45-CM; AD-668910)

The findings of recent tests on aged and used nylon parachutes are reviewed with respect to service life limits and to implications as to the technical nature of the degradation problem. The data tend to confirm that the current 10 year or 100 jump limits and related repair cost limit schedules do not present a hazard. However, the scatter and contrasts of results make questionable the validity of small samplings and extended predictions. No consistent and pervasive trends were found to be directly related to time in storage or service, or to jump history except for initial mechanical effects on suspension lines. The results evidenced marked differences in the specific susceptibilities of various materials, and a number of degrading influences and types of effects on physical properties. It is concluded that a wide distribution of strength levels is to be expected in older parachute populations, and that the risk problem is with the exceptional cases rather than with the average condition. A number of possible chemical and structural change mechanisms are discussed. Author (TAB)

N68-27407*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SYNTHESIS OF ULTRAHIGH MOLECULAR WEIGHT POLY(ETHYLENE TEREPHTHALATE)

Li-chen Hsu [1967] 19 p refs Presented at the Cryogenic Polymers Conf. Sponsored by NASA and Case Inst. of Tech., Cleveland, 25–27 Apr. 1967
(NASA-TM-X-60501) CFSTI: HC$3.00/MF$0.65 CSCL 11I

Poly(ethylene terephthalate) of number average molecular weight of the order of 120,000 was prepared from commercial grade material in the solid state with a gas chromatograph apparatus. Parameters studied were the catalyst, particle size, the molecular weight of the starting material, the reaction temperature and time, and the nature and flow rate of the carrier gas. Author

N68-27427*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

RESEARCH ON BORON FILAMENTS AND BORON REINFORCED COMPOSITES

Harvey W. Herring, Robert M. Baucom, and Richard A. Pride [1966] 21 p refs Presented at the 1966 SAMPE Symp. on Composite Mater., San Diego, Calif., 9–11 Nov. 1966
(NASA-TM-X-59224) CFSTI: HC$3.00/MF$0.65 CSCL 11D

A research program was conducted to explore the potential of boron filament for possible use as the reinforcing phase in composite materials for aerospace structures. The first part of this program was devoted to the evaluation of individual filaments with respect to their mechanical properties. The second part of the research effort was devoted to the evaluation of boron reinforced composites made by winding tapes preimpregnated with Epon 826-Z epoxy resin. Three basic specimen configurations were studied: rings, belts, and cylinders. Several glass specimens of each type were fabricated for comparison with boron specimens. A weight study of a series of large-scale cylinders designed for axial compression and internal or external pressure was performed based upon the elastic constants and tensile strengths obtained from the previously discussed experimental program. The results of this study showed a weight advantage of the boron–epoxy cylinders compared to the glass–epoxy cylinders of about 40 percent for compressive applications; however, a 60-percent weight advantage in favor of the glass-epoxy cylinders resulted for the case of internal pressure loading. Author

N68-27432*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MOLECULAR ORIENTATION AND MECHANICAL ANISOTROPY IN POLYMER FILMS
Howard L. Price [1967] 19 p refs Presented at the Silver Anniv. Ann. Tech. Conf. of the Soc. of Plastics Engineers, Detroit, 15–19 May 1967
(NASA-TM-X-59874) CFSTI: HC$3.00/MF$0.65 CSCL 11I

Results are presented of measurements of the molecular orientation and of the effect of such orientation on the mechanical properties of some polymer films. A sonic pulse method of detecting orientation is described, and orientation scans are presented of polyethylene, polypropylene, and poly(ethylene terephthalate) film. The mechanical anisotropy is shown by the variation of the tensile properties and the relaxation modulus as a function of direction in the plane of the film. The orientation and anistropy are compared and some practical aspects of the anisotropy are reviewed. Author

N68-27526*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLEXIBLE REINFORCED COMPOSITE WINDOW MATERIAL
Jerry G. Williams [1967] 29 p refs Presented at the 3d Aerospace Expandable and Modular Struct. Conf., Miami Beach, Fla., 16–18 May 1967
(NASA-TM-X-60137) CFSTI: HC$3.00/MF$0.65 CSCL 11D

This paper presents the results of an investigation to determine the feasibility of reinforcing a flexible transparent matrix with high-strength filaments in a rectangular grid pattern to form a flexible window for use in a manned expandable space structure. Experimental results of the effect of the space environment on optical and mechanical properties of the candidate matrix, reinforcement, and composite materials are given. Two concepts for attaching the window as an intrgral part of an expandable structure are presented. Author

N68-27584# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RHEOLOGICAL PROPERTIES OF POLYMERS IN THE FLUID STATE [REOLOGICHESKIYE SVOYSTVA POLIMEROV V TEKUCHEM SOSTOYANII]
G. V. Vinogradov and A. Ya. Malkin *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 103–114 refs (See N68-27575 16-23)

The rheological properties of polymers were investigated in an effort to obtain mathematical models of observed physical phenomena. Tests were performed upon the commercial polymers polybutylene P-20, polypropylene OP-30, certain polyethylenes, polystyroles, and others. Testing equipment included rotation viscosimeter REV-1 and a capillary constant pressure viscosimeter. Deforming stress was measured with respect to relative deformation at various temperatures and various constant speeds of deformation. The authors developed a temperature invariant form of presenting polymer strength characteristics. The experimental data which led to the establishment of the empirical formula are given in a logarithmic graph of η/η_o vs τ/η_o. The temperature invariant stress vs time relationship is given and experimental data are plotted to demonstrate this relationship. Author

N68-27585# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
POLYMER CREEP IN THE VITREOUS STATE [O POLZUCHESTI POLIMEROV V STEKLOOBRAZNOM SOSTOYANII]
A. V. Dolgov and N. I. Malinin *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 115–126 refs (See N68-27575 16-23)

The deformation properties of amorphous fiber glass polymers were studied analytically and experimentally, using the stress-strain integral equation modified to yield a nonlinear Volterra equation. The material under study was unplasticized polyvinylchloride (PVC) at T = 19°C, and the experiment was carried out on a programmed machine with magnetic loading. Three different methods were used to determine the "instantaneous" elasticity $F(\sigma) = \sigma/E$, and all three gave the same value for the modulus E. The creep deformation $\epsilon[c]$ versus t curves were plotted logarithmically with the empirical result $\epsilon[c] = A_1 t^n$ where A_1 and n are functions of the stress σ. Experimental determination of $f_1(\sigma)$ leads to a value given by $A_2 \mathrm{sh}\, \sigma/\sigma_0$, where $A_2 = 1.64 \times 10^5$ and $\sigma_0 = 1.086$ kg/mm². Curves were also obtained depicting ϵ versus t where the load was increased in steps. For this purpose, the integral equation is written as a summation, and the calculated results agreed with the data points very favorably. A cyclic load–unload type deformation-time curve showed that under load-on conditions the creep deformation increases, whereas, for no-load conditions, it decreases. Author

N68-27619# Melpar, Inc., Falls Church, Va.
A STUDY OF RANDOM NETWORK MODELS Final Report
Fred Ordway Apr. 1968 40 p refs
(Contract N00014-66-C-0258)
(AD-669125)

A second 300-unit tetrahedral network (Model II) has been constructed with an 18-unit nucleus selected from the earlier structure (Model I) so as to avoid the development of the regular structure of dodecahedral cages that formed a considerable part of Model I. The topological and geometrical statistics are similar to those of Model I, indicating that it should give a calculated radial distribution similarly close to that found by neutron diffraction for vitreous silica. Author (TAB)

N68-27623 Rutgers Univ., New Brunswick, N. J.
MECHANICAL DAMPING CAPACITY OF FUSED CAST ALUMINA
David Roderick Reid (Ph.D. Thesis) 1967 188 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-9261

An electromagnetic technique was used to determine the mechanical damping capacity of fused cast alumina by means of the dynamic resonant-beam method. The major source of mechanical damping in fused cast alumina was determined to be interface damping. Because interface damping in alumina castings is directly dependent upon the amount of intergranular bonding, mechanical damping capacity may be used as a nondestructive measure of the

strength of fused cast alumina structures. The correlation of strength and damping capacity was found to be much better than the correlation of strength and Young's modulus. Because interface damping is also dependent upon the differences in elastic constants within the casting structure, it was found that the correlation between mechanical damping capacity and strength could only be made for alumina castings of the same composition.
Dissert. Abstr.

N68-27629 California Univ., Los Angeles.

FRACTURE STRENGTH OF FIBER REINFORCED COMPOSITES

Robert Bruce McKee, Jr. (Ph.D. Thesis) 1967 111 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-9890

A new theory for the failure of parallel fiber reinforced composites is proposed. Failure is defined as the rapid propagation of a crack transverse to the fibers. The crack is nucleated by the enhancement of stress in the fibers surrounding a random break. Crack propagation occurs when the overall stress is high enough that the expected number of new breaks around a typical crack nucleus is at least one. Existing theories for failure are discussed. The results of previous research on glass and other fine filaments are analyzed. The stresses in fibers near a crack nucleus are calculated.
Dissert. Abstr.

N68-27774# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

CERAMIC SYSTEMS FOR MISSILE STRUCTURAL APPLICATIONS **Summary Report, 17 Dec. 1966–16 Dec. 1967**

N. E. Poulos, C. A. Murphy, and P. Boland Apr. 1968 37 p refs
(Contract N00017-67-C-0053)
(A-994; AD-668866)

The research program conducted during the contract year is described. Report is abbreviated to provide broad interpretation of program. Specific details of completed investigations offering improvements in the state-of-the-art are to be presented in Special Technical Reports. Three such reports prepared concurrently with this report are available from the Defense Documentation Center, and the respective titles are Composite Thermal Protection Systems, Characterization of Commercial Fused Silica Slips, and Guidelines for the Establishment of Optimal Heat-Treatment Process Parameters for Slip-Cast Fused Silica Components. Areas of study included embedded ablator concept for thermal protection systems, characterization of commercially available fused silica slips, time-temperature-thickness relationships for sintering of SCFS hardware, determination of the influence of grinding on the particle distribution, time-temperature-cristobalite behavior and physical properties of pure fused silica, and fabrication of SCFS radome structures and attachments for thermal evaluation in the General Dynamics/Pomona Ordnance Aerophysics Laboratory Typhon Combustor.
Author (TAB)

N68-27795# Forest Products Lab., Madison, Wis.

FOREST PRODUCTS LABORATORY LIST OF PUBLICATIONS ON GLUE, GLUED PRODUCTS, AND VENEER

Apr. 1968 37 p
(AD-668836)

Annotated bibliographies are presented on the development of waterproof glues, preparation and application of various glues, and plywood manufacturing problems. Consideration is given to (1) gluing of wood and other materials, (2) durability of glues, (3) plywood and veneered panels, (4) particleboard, (5) laminated wood and glued assemblies, (6) veneer, and (7) fundamentals of adhesion.
B.S.D.

N68-27814*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PROPERTIES OF POLYIMIDAZOPYRROLONES

Vernon L. Bell and Robert A. Jewell [1967] 12 p Presented at Am. Chem. Soc., Spring Natl. Meeting, Symp. on Ladder and Spiro Polymers, Miami, Fla., 9–14 Apr. 1967
(NASA-TM-X-59873) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Polyimidazopyrrolone (pyrrone) synthesis procedures are described, their theoretical structures are depicted, and the solution properties of polyimide precursors of the pyrrones are listed. The typical tensile properties of poly(imidazopyrrolone) films are assessed, and it was found that the film properties were quite independent of the curing atmosphere. However, ultimate curing temperature was noted to exert a marked influence on the mechanical properties. The data indicate a general increase in strength and modulus, together with a corresponding decrease in elongation, as the ultimate curing temperature was increased. Experiments on the resistance of polymer films to degradative effects of ionizing radiation both in air and in vacuum indicate that, although some degradation may have begun after 21,000 megarads of 3 MeV electrons, the tensile properties of the films after the extreme dose of 28,000 megarads were still nearly equivalent to the initial values.
M.G.J.

N68-27828 Purdue Univ., Lafayette, Ind.

CONSTITUTIVE EQUATIONS FOR VISCOELASTIC MATERIALS

Michael Lee White (Ph.D. Thesis) 1967 182 p
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-10274

Polymer solutions and melts usually exhibit such non-Newtonian behavior as shear-dependent viscosity, normal stresses, stress buildup and relaxation, and elastic recovery. Finding a constitutive equation flexible enough to describe these viscoelastic phenomena, yet suitable for engineering purposes, is the primary objective of this work. Using the continuum mechanics approach, a general constitutive equation for homogeneous, isotropic, incompressible, and isothermal materials is developed. The proposed constitutive equation is the most general single-integral approximation of the Coleman–Noll "simple fluid." Stress calculations for various fluid motions provide the method for testing constitutive equations. Several models, including one which is proposed, are investigated.
Dissert. Abstr.

N68-27916*# TRW Systems, Redondo Beach, Calif.

TRW MATERIALS COMPATIBILITY STUDY WITH ETHYLENE OXIDE/FREON 12 DECONTAMINATION PROCESSES

J. K. Okumura 14 Sep. 1967 55 p refs
(Contract NAS8-20864)
(NASA-CR-61604; TRW-09133-6003-R000) CFSTI: HC $3.00/MF $0.65 CSCL 11

A test program was conducted to provide quantitative information on the compatibility of the materials currently used in the lunar module descent engine (LMDE) with the type approval and flight approval ethylene oxide (ETO) decontamination process. An extensive literature search revealed that all of the metallics used on LMDE has an established history of compatibility with the ETO decontamination environment whereas the compatibility of many of the organic materials with this process was either unknown or doubtful. Based on this investigation, 21 different materials were selected for compatibility verification. All but one of these materials were organic in nature. The decontamination tests consisted of seven cycles, 28 hours each in duration, of exposure to the ETO/Freon 12 decontamination environment. Test results on each material are tabulated.
Author

N68-28043*# Pennsylvania State Univ., University Park. Materials Research Lab.
RESEARCH ON THE MECHANISM AND KINETICS OF OXIDATION OF SILICON IN AIR Semiannual Report, 1 Dec. 1967–31 May 1968
K. Vedam, E. Schmidt, and W. Knausenberger 17 Jun. 1968 35 p refs
(Grant NGR-39-009-042)
(NASA-CR-95355; SAR-6) CFSTI: HC $3.00/MF $0.65 CSCL 11F

From a series of ellipsometric measurements it is not possible to obtain uniquely all the optical parameters of the system: absorbing substrate + non-absorbing surface film. The method utilizes the fact that the reflectivity of such a system remains essentially constant for a small but finite range of surface film thicknesses. Furthermore it hinges on the fact that the ellipsometric parameters Δ and ψ measured on different film thicknesses grown on the same sample, are compatible with only one unique choice of the parameters n_2, k_2, and n_1. Measurements on chemically etched samples of silicon yield the values of the optical parameters as $n_2=4.052$ and $k_2=0.029$ in agreement with the results of earlier workers. The results on the cleaved samples of silicon, on the other hand, reveal that the true values are $n_2=4.14_0$ and $k_2=0.03_4$ for λ5461Å. Author

N68-28062# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf.
ROENTGENOGRAPHIC ANISOTROPY DETERMINATION ON PYROCARBONS [ROENTGENOGRAPHISCHE ANISOTROPIEBESTIMMUNG AN PYROKOHLENSTOFF]
H. Maerkl, P. Koss, and H. Bruneder 1968 22 p refs In GERMAN Submitted for publication
(SGAE-M-17/1968) CFSTI: HC $3.00/MF $0.65

Described is a simple method for measuring the anisotropy factor of pyrolytic carbon for predicting the behavior of coated nuclear fuel particles under reactor conditions. The method is suitable for automation, employs a texture goniometer and a Geiger counter for intensity measurements, and can also be used for measuring other materials. Samples of several 100 μ thickness or width and several millimeters length can be measured with this method. Transl. by K.W.

N68-28116# Atomic Weapons Research Establishment, Aldermaston (England).
THE VALUE OF TRACE ANALYSIS IN THE COMPARISON OF GLASS FRAGMENTS—A PRELIMINARY STUDY
R. F. Colemen and G. A. Wood Apr. 1968 17 p refs Sponsored by the Home Office
(AWRE-O-3/68) CFSTI: HC $3.00/MF $0.65

Consideration is given to emission spectroscopy, mass spectrometry and activation analysis as methods of glass analysis. Results obtained by neutron activation of glass samples are reported and considered in relation to the forensic problem of fragmentation comparison. Author

N68-28264*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CRITERIA FOR SELECTION OF WIRE INSULATIONS FOR USE IN SPACE APPLICATIONS
Vernon Krueger Washington Jul. 1968 17 p refs
(NASA-TN-D-4553) CFSTI: HC $3.00/MF $0.65 CSCL 11I

The properties of five electrical insulation materials (Teflon TFE, Teflon FEP, Specification 44 outer space insulation, Novathene, and modified Rayolin-N) were compared, to provide a guide for selecting wire insulations in spacecraft. Of all the properties considered, the outgassing characteristics, radiation resistance, and weight of the materials were considered most important for space applications. Also considered were the workability of these insulations and the amount of fabrication deterioration that wires and cables using them can withstand. Author

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N68-26959# Stanford Univ., Calif. Dept. of Computer Science.
INTERVAL ARITHMETIC DETERMINANT EVALUATION AND ITS USE IN TESTING FOR A CHEBYSHEV SYSTEM
Lyle B. Smith 26 Apr. 1968 29 p refs
(Contract Nonr-225(37))
(CS-96; AD-668558)

Two recent papers by Hansen and by Hansen and R. R. Smith have shown how interval arithmetic (I.A.) can be used effectively to bound errors in matrix computations. This paper compares a method proposed by Hansen and R. R. Smith to straightforward use of I.A. in determinant evaluation. Computational results show what accuracy and running times can be expected when using I.A. for determinant evaluation. An application using I.A. determinants in a program to test a set of functions to see if they form a Chebysev system is then presented. Author (TAB)

N68-26969# Texas Univ., Austin. Computation Center.
ON THE QUADRATIC CONVERGENCE OF A GENERALIZATION OF THE JACOBI METHOD TO ARBITRARY MATRICES Interim Technical Report
Axel H. Ruhe Dec. 1967 41 p refs
(Grants DA-ARO(D)-31-124-G721; NSF GP-5253)
(ITR-16; AROD-3772.34-M; AD-668912)

A method of diagonalizing a general matrix is proved to be ultimately quadratically convergent for all normalizable matrices. The method is a slight modification of a method due to P. J. Eberlein, and it brings the general matrix into a normal one by a combination of unitary plane transformations and plane shears (non-unitary). The method is a generalization of the Jacobi Method in that for the case of normal matrices it is equivalent to the method which is given by Goldstine and Horwitz. Author (TAB)

N68-26983# Syracuse Univ., N. Y.
SEQUENTIAL BOOLEAN EQUATIONS Interim Report
Shimon Even (Harvard Univ., Cambridge, Mass.), and Albert R. Meyer (Carnegie–Mellon Univ.) Griffiss AFB, N. Y. RADC Apr. 1968 41 p refs
(Contract F30602-68-C-0013)
(RADC-TR-67-629; AD-668771)

The problem of solving sequential Boolean equations is shown to be equivalent to the problem of finding whether there exists a path on a labeled graph for every sequence of labels. Algorithms are given for testing whether a solution exists. In case of existence of solutions the algorithms provide them. Author (TAB)

N68-27027# Carnegie–Mellon Univ., Pittsburgh, Pa. Management Sciences Research Group.
RISK AVERSION IN STOCHASTIC PROGRAMMING WITH RECOURSE
David Rutenberg Feb. 1968 22 p refs
(Contract Nonr-760(24))
(RR-122; AD-667968)

In stochastic programming with recourse the objective is to maximize expected net payoff. This implicitly assumes no aversion to risk. This paper introduces risk aversion into stochastic programming with recourse. The objective becomes to maximize the expected (concave) utility of the net payoffs. Because of the special structure of the problem a number of computational short cuts are possible in the mathematical program that results. The latest representation of the gradient is but a slight modification of the latest representation of the linear objective function without risk aversion. All the second stage problems can be solved as linear programs. Unfortunately it appears necessary to solve the first stage problem as a non-linear program. Author (TAB)

N68-27033 Brown Univ., Providence, R. I.

NUMERICAL ERRORS IN ITERATIVE PROCESSES

George Oliver Gardner, III (Ph.D. Thesis) 1966 95 p refs
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-2240

In this dissertation Urabe's results are extended to the case where F is a superlinear iterative process. Next, assuming the conditions of Kantorovitch's theorem are satisfied, the effects of numerical errors on Newton's iteration process are investigated. Finally, a computer program which solves polynomial equations is described. This program uses Kantorovitch's theorem to check if a given starting value is close enough to the desired root for Newton's method to converge. It also automatically changes the precision of arithmetic as the calculations proceed so that a root can be found to any prescribed accuracy. An example of its operation is provided. Dissert. Abstr.

N68-27068# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.

TESTING FOR EQUALITY OF MEANS, EQUALITY OF VARIANCES AND EQUALITY OF COVARIANCES UNDER RESTRICTIONS UPON THE PARAMETER SPACE

Leon Jay Gleser and Ingram Olkin Jul. 1967 27 p refs
(Contract Nonr-4010(09); Grant NSF G-6681)
(TR-76; AD-668147)

Suppose that the p-dimensional random row vector X has a multivariate normal distribution with mean mu and covariance matrix sigma. Wilks (Ann. Math statist. 17 (1946)) has derived likelihood-ratio tests of the hypothesis H sub MVC and H sub VC against general alternatives H. Here H sub MVC is the hypothesis that the components of the mean vector mu are equal (mu = eta (1, 1, ..., 1) is identical with eta E, where eta is an unknown constant) and that sigma has the intraclass correlational form sigma = sigma squared ((1-rho)I + rho E E prime). H sub VC is the hypothesis that sigma has the intraclass correlational form, mu unrestricted; H is the hypothesis that mu is unrestricted and sigma is unrestricted, positive definite. In the present paper, we consider likelihood ratio tests of the hypotheses HR sub MVC and HR sub VC against general alternatives H, where HR sub MVC and HR sub VC differ from H sub MVC and H sub VC, respectively, by constricting the common correlation to lie in an interval rho sub 0 = or < rho < 1. Such tests have practical importance in psychological testing theory, in the analysis of growth curves, and in other contexts. Author (TAB)

N68-27094# RAND Corp., Santa Monica, Calif.

THE RECURSIVE UNSOLVABILITY OF THE DECISION PROBLEM FOR THE CLASS OF DEFINITE FORMULAS

R. A. Di Paola Apr. 1968 12 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5639-PR; AD-668755)

A class of formulas of the first-order predicate calculus--the definite formulas--have recently been proposed as formal representations of reasonable questions to be processed by an actual data retrieval system known as the Relational Data File. It is shown in this study that the decision problem for the class of definite formulas is recursively unsolvable. Hence there is no algorithm that can be used to decide whether or not a given formula is definite. Author (TAB)

N68-27115# California Inst. of Tech., Pasadena.

AN EXTENSION OF A THEOREM OF DE BRUIJN AND ERDOS ON COMBINATORIAL DESIGNS

H. J. Ryser [1968] 28 p refs
(Contract N00014-67-A-0094-0010)
(AD-668526)

The paper presents several theorems that extend a previous theorem of De Bruijn and Erdos (1948) on combinatorial designs. TAB

N68-27153# Cornell Univ., Ithaca, N. Y. Dept. of Operations Research.

MULTIPLE COMPARISONS WITH A CONTROL FOR MULTIPLY CLASSIFIED VARIANCES OF NORMAL POPULATIONS

Robert E. Bechhofer Feb. 1968 11 p refs
(Contracts DA-31-124-ARO(D)-474; Nonr-401(53))
(TR-42; AD-668920)

Dunnett has prepared tables for making multiple comparisons with a control for single-factor (or multi-factor) experiments involving means of normal populations. In the present paper the author uses the multiplicative model for variances which he introduced in an earlier paper, as the basis for making multiple comparisons with a control for multi-factor experiments involving variances of normal populations. A limited set of tables for use with this procedure is included. Author (TAB)

N68-27174# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FUNCTIONAL ANALYSIS

S. G. Kreyn, ed., H. Ya. Vilenkin, Ye. A. Gorin, A. G. Kostyuchenko, M. A. Krasnosel'skiy et al 7 Jul. 1967 361 p refs Transl. into ENGLISH of the book "Funktsional'nyy Analiz" Moscow, Izd. Nauka, 1964 p 1-424
(FTD-MT-65-573; AD-668932)

This issue in a series of Handbooks of the Mathematical Library contains much material grouped basically around the theory of operators and operator equations. It presents the basic concepts and methods of functional analysis, theory of operators in Hilbert space and in conical space, the theory of nonlinear operator equations, the theory of standard rings applied to equations in partial derivatives, to integral equations. A separate chapter is devoted to the basic operator of quantum mechanics. Citing of the theory of generalized functions takes up a large part of the book. The book explains mathematical facts; theorems and formulas, as a rule, are given without proofs. TAB

N68-27192# Purdue Univ., Lafayette, Ind. Div. of Mathematical Sciences.

MORE ON A CHEBYSHEV-TYPE INEQUALITY FOR SUMS OF INDEPENDENT RANDOM VARIABLES

S. M. Samuels Apr. 1968 22 p refs *Its* Mimeograph Ser. No. 155
(Contract Nonr-1100(26))
(AD-668978)

The paper deals with the same problem and the same conjectured solution to it which was considered in Samuels (Ann. of Math. Statistics, 1966). Section 2 contains a restatement of the problem. Section 3 contains a simpler proof of the conjecture for n = or < 3 and, for the first time, a proof for n = 4. Section 4 contains what is essentially a simpler proof of Theorem 5.1 of Samuels (Ann. of Math. Statistics, 1966). Section 5 contains proof that the conjecture is true for large lambda. Author (TAB)

N68-27245# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PROPERTIES OF GENERALIZED SOLUTIONS OF LINEAR EQUATIONS OF THE ELLIPTIC AND PARABOLIC TYPES [K VOPROSU O SVOYSTVAKH OBOBSHCHENNYKH RESHENIY LINEYNYKH URAVNENIY ELLIPTICHESKOGO I PARAGOLICHESKOGO TIPOV]

A. V. Ivanov *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 3–15 refs (See N68-27244 16-23)

Generalized solutions of linear elliptic and parabolic equations from the classes $W_2^1(\Omega)$ and $W_2^{1,0}(W_T)$ correspondingly are considered. Some examples, which show the unimprovability of certain results due to O. A. Ladizhenskaya and N. N. Uraltseva related to the properties of generalized solutions from these classes, are constructed. Author

N68-27246# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ONE CLASS OF FAMILY OF DISTRIBUTIONS, POSSESSING SIMILAR ZONES [OSIN KLASS SEMEYSTV RASPREDELENIY, DOPUSKAYUSHCHIKH]

A. M. Kagan and Yu. V. Linnik *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 16–19 refs (See N68-27244 16-23)

It is proved that under some conditions the families of distributions of type (1) $p(x;\theta) = R_1(x;\theta)r_1(x) + ... + R_m(x;\theta)r_m(x)$, possess the nontrivial similar regions. This result generalizes the corresponding result of Yu. V. Linnik to the case of abstract parameter. Author

N68-27247# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF ARITHMETICAL PROPERTIES OF VALUES OF POLYNOMIALS [K IZUCHENIYU ARIFMETICHESKIKH SVOYSTV ZNACHENIY MNOGOCHLENOV]

D. N. Lenskoy *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 20–32 refs (See N68-27244 16-23)

Let $F(\xi_1, \xi_2, \ldots, \xi_t)$ be a polynomial over an imaginary quadratic field with integral coefficients. Under certain suppositions about $F(\xi_1, \xi_2, \ldots, \xi_t)$ and about the way $\xi_1, \xi_2, \ldots, \xi_t$ vary, an upper bound is found for the quantity of ideals $(F(\xi_1, \xi_2, \ldots, \xi_t)) = P_1P_2 \ldots P_l$, $l \leq f$, f being an integer connected with $F(\xi_1, \xi_2, \ldots, \xi_t)$ in the definite manner. Author

N68-27248# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT CONTINUITY OF SOLUTIONS OF DIFFERENTIAL EQUATIONS IN A PARAMETER [O NEPRERYVNOSTI RESHENIY DIFFERENTSIAL'NYKH URAVNENIY PO PARAMETRU]

N. N. Petrov *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 33–42 refs (See N68-27244 16-23)

The continuous dependence on the parameter λ of the solution of equation $dx/dt = X(t, x, \lambda)$ is considered (X and x being m-dimensional vectors). In some cases necessary and sufficient conditions are obtained. Author

N68-27249# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY OF LINEAR HAMILTONIAN EQUATIONS WITH PERIODIC COEFFICIENTS IN HILBERT SPACE [OB USTOYCHIVOSTI LINEYNYKH GAMIL'TONOVYKH URAVNENIY S PERIODICHESKIMI KOEFFITSIENTAMI V GIL'BERTOVOM PROSTRANSTVE]

V. N. Fomin *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 43–53 refs (See N68-27244 16-23)

It has been established that the multiplicators of the Hamiltonian equation can be decomposed in a natural way into first and second order multiplicators. Moreover, the equation is highly stable if all of its multiplicators are located on the unit circle and if among them there are no multiples of various orders. The converse of this assertion has also been proven. It turns out that an analogous statement can be made also for a linear, Hamiltonian equation in a Hilbert space if the coefficients of the equation are bounded operators. In order that the Hamiltonian equation be highly stable it is necessary and sufficient that the spectrum of the monodromy operator be located on the unit circle and not have points of mixed orders. Two other theorems are also proven. Author

N68-27250# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORY OF CURVES IN THE MINOWSKI SPACE [THEORIYA KRIVYKH V PROSTRANSTVE MINKOVSKOGO]

B. Frank *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 54–66 refs (See N68-27244 16-23)

A Minkowsky space is a four-dimensional pseudo-euclidean space ${}^1R_4$ of index 1. Regular curves in this space, depending on whether their tangent, normal and binormal vectors are less than, greater than or equal to zero, can be separated into seven classes. The traditional method of the moving n-hedron can be applied to curves of classes 1–4 without difficulty; it is not applicable to curves of classes 5–7 because of the peculiarity of isotropic vectors that they cannot be normalized and cannot form a part of an orthonormalized basis of space ${}^1R_4$. In the present paper, this method is used for curves of all classes and, moreover, is successful in relating to curves of classes 2–7 a moving tetrahedron specialized in such a form that we obtain an analog of the Frenet formula having the form of the well-known Frenet formula for curves of class 1. Here, only the curves with euclidean and isotropic tangents have to be studied separately. The work is based on the fact that for curves with euclidean or isotropic tangents, an imaginary unit vector of the tetrahedron is arbitrarily fixed. During the course of the paper, nine theorems are proven. Author

N68-27259# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON BOUNDEDNESS OF SOLUTIONS OF ONE SYSTEM OF DIFFERENTIAL EQUATIONS OF THE THIRD ORDER [OB OGRANICHENNOSTI RESHENIY ODNOY SISTEMY DIFFERENTSIAL'NYKH URAVNENIY TRET'EGO PORYADKA]

Ye. S. Anitova *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 181–184 refs (See N68-27244 16-19)

The sufficient conditions of the boundedness of all solutions of equation: $dx/dt = a_{11}x + a_{12}y + a_{13}z + p_1(t, x, y, z)$, $dy/dt = f(x) + a_{22}y + a_{23}z + p_2(t, x, y, z)$, and $dz/dt = a_{31}x + a_{32}y + a_{33}z + p_3(t, x, y, z)$ by the same constant for large t are given. This system has the ω-periodic solution under the same conditions if $p_i(t + \omega, x, y, z) = p_i(t, x, y_i, z)$. Author

N68-27260# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT ONE INTEGRAL EQUATION USED IN STATISTICS [OB ODNOM INTEGRAL'NOM URAVNENII, VSTRECHAYUSHCHEMSYA V STATISKIE]

D. V. Anosov *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 185–190 refs (See N68-27244 16-19)

The integral equation expressing the stochastic independence of the sample mean and tube statistics is solved in the class of the continuous probability densities. Author

N68-27262# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE INDEX OF DEFICIENCY OF SECOND AND THIRD BOUNDARY PROBLEMS IN THE DOMAIN WITH A PIECEWISE SMOOTH BOUNDARY [OB INDEKSE DEFEKTA VTOROY I TRET'EY KRAYEVYKH ZADACH V OBLASTI S KUSOCHNO-GLADKOY GRANITSEY]

G. M. Verzhbinskiy *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 199–201 ref (See N68-27244 16-19)

The deficiency number for the second and third boundary value problems in the domains with a piecewise-smooth boundary is found. Author

N68-27263# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON SOLVABILITY OF DIRICHLET PROBLEMS FOR A REGION WITH A SMOOTH IRREGULAR BOUNDARY [O RAZRESHIMOSTI DIRIKHLE DLYA OBLASTI S GLADKOY NEREGULAYARNOY GRANITSEY]

V. G. Maz'ya *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 202–205 refs (See N68-27244 16-19)

Let the boundary of a plane domain D be a simple smooth contour C with bounded variation of rotation. The second order elliptic equation $ar + 2bs + ct = f$ with the boundary condition $u = 0$ is considered. Some criteria for solubility in $\overset{\circ}{W}_2(2)$ of this problem are obtained. It is shown that the lack of regularity of the curve C gives rise to the following anomaly previously unknown—the problem under consideration can be solvable in $\overset{\circ}{W}_2(2)$ for Laplace's operator and not always solvable for any elliptic operator $ar + 2bs + ct$ with constant coefficients. In conclusion a condition for the boundedness of the first derivatives of the solution is stated. Author

N68-27309# Cornell Univ., Ithaca, N. Y. Dept. of Operations Research.

SINGLE-STAGE PROCEDURES FOR RANKING MULTIPLY-CLASSIFIED VARIANCES OF NORMAL POPULATIONS

Robert E. Bechhofer Feb. 1968 44 p refs
(Contracts DA-31-124-ARO(D)-474; Nonr-401(53))
(TR-41; AD-668921)

The author and Sobel have proposed single-stage procedures for ranking the variances of normal populations which are classified according to a single qualitative factor. Using the multiplicative model for variances introduced by the author in an earlier paper, it is shown how to generalize these procedures so that they can deal with situations in which the variances are classified according to two or more qualitative factors. The rationale of such experiments is discussed. Goals and associated probability requirements and procedures are described. Explicit expressions for the exact probability of a correct selection, using the proposed procedures, are obtained for certain special cases. The determination of sample size to guarantee the probability requirement is considered, large-sample approximations to these sample sizes are given, and the accuracy of the approximations is assessed. Author (TAB)

N68-27400*# Rochester Univ., N. Y. Dept. of Electrical Engineering.

LYAPUNOV FUNCTIONS AND THE EXACT DIFFERENTIAL EQUATION

Edwin Kinnen and Chiou-Shiun Chen 2 Dec. 1966 10 p refs
Presented at the Joint Autom. Control Conf., Philadelphia, 29–30 June 1966
(Grant NsG-574)
(NASA-CR-80204) CFSTI: HC$3.00/MF$0.65 CSCL 12A

Lyapunov functions are considered from the viewpoint of exactness of the differential equations. It is shown that the search for possible Lyapunov functions can be restated in terms of conditions for exactness and sign-definiteness. This procedure allows a generalization of many well-known techniques that are described in the literature. Author

N68-27425# Michigan State Univ., East Lansing. Dept. of Statistics and Probability.

INADMISSIBILITY OF THE BEST INVARIANT TEST WHEN THE MOMENT IS INFINITE UNDER ONE OF THE HYPOTHESES

Martin Fox and S. K. Perng Apr. 1968 8 p refs
(Contract DA-31-124-ARO(D)-462; Nonr-2587(02))
(RM-208; AD-668665)

This note contains an example which shows that a unique best invcriant test may be inadmissible when certain moment is infinite under one of the hypotheses. Author (TAB)

N68-27451 California Univ., Berkeley.

THE MULTI-COMMODITY MAXIMUM FLOW PROBLEM

Michel Sakarovitch (Ph.D. Thesis) 1966 63 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-8642

This thesis is concerned with the problem of maximizing the sum of the flows of different commodities in a capacitated network. From theoretical results an algorithm is given which constructs, in a finite number of steps, the multi-commodity maximum flow. The constraints under which the total flow has to be maximized are threefold: non-negativity of flow, capacity, and conservation. It is to be noted that the nice combinatorial features of the one-commodity flow problem are lost when we deal with many commodities: the max flow min cut theorem is not valid and the integrity property of the solution is lost. The problem is a linear program for which Ford and Fulkerson gave a method of solution by decomposition. The method presented here, except for a linear system of limited size which has to be solved at each step, is a labelling process. The concepts of blocking flow (a situation such that if the flows of all commodities but commodity i are held fixed, there is no i-flow augmenting path) and blocking set are introduced. A criterion to decide when a blocking flow is optimal is given. Then a method is proposed to improve a non optimal blocking flow by a positive amount each time changing the blocking set. Dissert. Abstr.

N68-27457*# Pittsburgh Univ., Pa.

LYAPUNOV STABILITY FOR PARTIAL DIFFERENTIAL EQUATIONS. PART 1: LYAPUNOV STABILITY THEORY AND THE STABILITY OF SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS. PART 2: CONTRACTION GROUPS AND EQUIVALENT NORMS

Gabe R. Buis, William G. Vogt, and Martin M. Eisen Washington NASA Jun. 1968 127 p refs
(Grant NGR-39-011-039)
(NASA-CR-1100) CFSTI: HC$3.00/MF$0.65 CSCL 12A

CONTENTS:

1. LYAPUNOV STABILITY THEORY AND THE STABILITY OF SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS G. R. Buis p 1–113 refs (See N68-27458 16-19)

2. CONTRACTION GROUPS AND EQUIVALENT NORMS W. G. Vogt, M. M. Eisen, and G. R. Buis p 114–122 refs (See N68-27459 16-19)

N68-27458*# Pittsburgh Univ., Pa.

LYAPUNOV STABILITY THEORY AND THE STABILITY OF SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS

Gabe Rinse Buis *In its* Lyapunov Stability for Partial Differential Equations. Part 1: Lyapunov Stability Theory and the Stability of Soln. to Partial Differential Equations. Part 2: Contraction Groups and Equivalent Norms Jun. 1968 p 1–113 refs (See N68-27457 16-19)

The Lyapunov stability theory is generalized to semi-groups and groups of linear operators in Hilbert spaces. The existence of a Lyapunov functional is sufficient for the asymptotic stability of semi-groups and necessary and sufficient for the asymptotic stability of groups. This theory is applied to a class of partial differential equations, yielding stability conditions which are mathematically rigorous. Author

N68-27459*# Pittsburgh Univ., Pa.

CONTRACTION GROUPS AND EQUIVALENT NORMS

William G. Vogt, Martin M. Eisen, and Gabe Rinse Buis *In its* Lyapunov Stability for Partial Differential Equations. Part 1: Lyapunov Stability Theory and the Stability of Soln. to Partial Differential Equations. Part 2: Contraction Groups and Equivalent Norms Jun. 1968 p 114–122 refs (See N68-27457 16-19)

In this report, necessary and sufficient conditions are obtained for a closed linear operator A to generate a group $\{T_t;\ -\infty < t < \infty\}$ in a Banach space such that $\{T_t;\ t > 0\}$ is a negative contractive semi-group with respect to an equivalent norm. These results are refined to the case of a group in Hilbert space. Author

N68-27474*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CHAIN POOLING ANOVA FOR TWO LEVEL FACTORIAL REPLICATION FREE EXPERIMENTS

A. G. Holms and J. N. Berrettoni (Western Reserve Univ.) Washington 1967 34 p refs Presented at the 127th Ann. Meeting of the Am. Statist. Assoc., Washington, D. C., 27–30 Dec. 1967

(NASA-TM-X-52317) CFSTI: HC$3.00/MF$0.65 CSCL 12A

In many experimental situations, a large portion of mean squares (including the higher-order interactions) may contain real effects. This paper introduces chain pooling, a procedure which decides the specific mean squares to be pooled for use as an estimate of error variance, and gives a procedure for determining significant treatment effects. The operating characteristics for various strategies of chain pooling were investigated by Monte Carlo methods for designs of 2^4 treatment combinations. These computations were performed with real effects whose magnitudes were distributed in a manner unfavorable to chain pooling. The actual type 1 and type 2 error probabilities depend on the magnitudes of the real effects. A method is given for estimating weighted average error probabilities after the real effects are estimated. The procedures are illustrated by an example. Author

N68-27632*# Oak Ridge National Lab., Tenn.

THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $-21\ N\ \lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES, PART 1. MINIMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL CHI-SQUARE DISTRIBUTION, PART 2

William Edwin Lever (Ph.D. Thesis—Fla. State Univ.) Mar. 1968 151 p refs

(Grants NGR-10-004-029; NIH GMS-5-1-GM-913; Contracts W-7405-ENG-26; Nonr-988(08))

(NASA-CR-95169; ORNL-4225) CFSTI: HC $3.00/MF $0.65 CSCL 12A

CONTENTS:

1. THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $-21N\lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES W. E. Lever p 1–56 (See N68-27633 16-19)
2. MINIMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL CHI-SQUARE DISTRIBUTION W. E. Lever p 57–143 (See N68-27634 16-19)

N68-27633*# Oak Ridge National Lab., Tenn.

THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $-21\ N\ \lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES

William Edwin Lever *In its* The Limiting Distribution of the Likelihood Ratio Statistic $-21\ N\ \lambda_n$ Under a Class of Local Alternatives, Pt. 1. Minimum Average Risk Decision Procedures for the Noncentral Chi-Square Distribution, Pt. 2 Mar. 1968 p 1–56 (See N68-27632 16-19)

Maximum likelihood properties and asymptotic distributions are considered in relation to the limiting distribution of the likelihood ratio statistic $(-21n\lambda_n)$ under a class of local alternatives. Asymptotic properties of null and non-null maximum likelihood estimators are discussed; and it is shown that the statistic converges in a distribution, not necessarily uniformly, to a noncentral chi-square distribution under the local alternatives to the null hypothesis. Consideration is limited to maximum likelihood estimates that are solutions to the likelihood equations obtained for the maximization process. M.W.R.

N68-27634*# Oak Ridge National Lab., Tenn.

MINIMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL CHI-SQUARE DISTRIBUTION

William Edwin Lever *In its* The Limiting Distribution of the Likelihood Ratio Statistic $-21\ N\ \lambda_n$ Under a Class of Local Alternatives, Pt. 1. Minimum Average Risk Decision Procedures for the Noncentral Chi-Square Distribution, Pt. 2 Mar. 1968 p 57–143 refs (See N68-27632 16-19)

Critical values given for two minimum average risk decision procedures are determined for the case when the loss function is a linear regret function and the noncentrality parameters are assumed to be random variables with continuous distributions. These are procedures for making decisions about the unknown noncentrality parameters of noncentral chi-square distributions, and a procedure is included for comparing the magnitude of noncentrality parameters. Aids to help in the use of decision procedures are discussed when the gamma prior distribution is assumed for the noncentrality parameter; and tables to facilitate decision making are included. Use of these tables assumes that the loss functions are linear in the noncentrality parameter and zero when the decision made is a true one. These decision procedures apply mainly to a function which will usually measure the distance between parameters or a subset of parameters of a specific distribution and a standard distribution. M.W.R.

N68-27676 Columbia Univ., New York.

APPLICATION OF GRAPH THEORY TO THE STRUCTURAL CLASSIFICATION OF MECHANISMS

Lew Dobrjanskyj (Ph.D. Thesis) 1966 242 p

Available from Univ. Microfilms: HC $11.05/MF $3.15 Order No. 67-9334

As a first step the dissertation defines the concepts of the structure of kinematic chains and mechanisms in a rigorous way and sets a criterion of degeneracy; a basic kinematic chain is defined as a closed non-degenerate chain whose number of links and joints satisfy Gruebler's equation. The theory of graphs is utilized to describe a kinematic chain and mechanism by a topological graph, in such a manner as to preserve a one-to-one correspondence between the elements of the graph and the elements of the kinematic chain. In such a representation, the links of a kinematic chain are represented by the vertices and the joints of the chain by the edges of the graph. This, in turn, leads to the representation of a kinematic chain or mechanism by a mathematical array, the incidence matrix. The relations between the matrices of a graph of kinematic chain are discussed in detail and expressed in matrix form. Dissert. Abstr.

N68-27681# North American Aviation, Inc., Anaheim, Calif. Autonetics Div.

THE MATHEMATICAL BASIS OF THE AUTONETICS ETCHED INTERCONNECTION DESIGN PROGRAM

John Weisman [1967] 15 p *Its* Paper No. 7

An example demonstrates how the mathematics of an etched interconnection program achieves a procedure that designs a multilayered etched interconnection board with the minimum number of layers. The procedure determines a coloring scheme for a mathematical map that uses the minimum number of colors; and the procedure is independent of the topological space containing the map. The procedure apparently does not shed light on the well-known and unresolved four-color map problem of mathematics. The example used imagines pins sticking out of the plane surface of a box of electronic components. A certain list of these pins is available, each pair of pins in this list is to be connected electrically, and there is a list of etched paths that can connect each of the pairs of pins. Multilayered boards are necessary because the paths must be contained in the board through which the pins protrude, and one board cannot usually contain all of the paths necessary to connect all of the pins. A geometric configuration for such a problem with 10 pins is illustrated. M.W.R.

N68-27737 Denver Univ., Colo.

THE DESIGN OF OPTIMAL, ADAPTIVE CLASSIFICATION FUNCTIONS FOR PATTERN RECOGNITION

Roy Louis Hoffman (Ph.D. Thesis) 1967 145 p

Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-9842

A foundation is developed for designing optimal, adaptive classification functions for pattern classification experiments where the pattern class statistics may be unknown. The formulation of classification functions is reviewed and parametric, nonparametric, as well as adaptive classifiers are all found to be minimum cost classifers. Most previous studies of simple, adative classifiers, which are more properly called adaptive, boundary-oriented classifiers, have emphasized that the pattern class distributions need not be known since there are not statistical classifiers. It is shown that *optimal* adaptive, boundary-oriented classifiers can be designed only when the pattern class statistics are available. Two aspects of adaptive classifer optimization are considered in detail. First the design of adaptive, boundary-oriented classifiers for known pattern class distributions is treated. Second, the design of adaptive classification functions for unknown pattern class distributions is considered. Dissert. Abstr.

N68-27757# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT ANALOGS OF TITCHMARSH'S DIVISOR PROBLEM [OB ANALOGAKH PROBLEMY DELITELIY TITCHMARSHA]

M. B. Barban *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 3–12 refs (See N68-27756 16-23)

A generalization of a dispersion method in binary additive problems, which makes it possible to bypass the expanded Riemann hypothesis, is used to prove an asymptotic formula. Author

N68-27758# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF ONE DISSIPATIVE SYSTEM OF THE SECOND ORDER [ISSLEDOVANIYE ODNOY DISSIPATIVNOY SISTEMY VTOROGO PORYADKA]

Yu. N. Bibikov *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 13–28 refs (See N68-27756 16-23)

A system of two differential equations is stated, and a solution is sought based on the assumptions that the right sides of the system are continuous functions; the functions $P(x, y, t)$ and $Q(x, y, t)$ are bound; and real numbers and a positive function exist so that generalized Hurwitz conditions can be satisfied. Sufficient conditions of the boundedness of all solutions by the same domain in the xy plane when $t \to +\infty$, and of the convergence of all solutions are established. The invariant set S of the transformation of the xy plane into itself generated by the system of equations, when $P(x, y, t)$ and $Q(x, y, t)$ are both periodic in t, is also investigated. M.G.J.

N68-27759# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE VALUE OF INFORMATION [TSENNOSTI INFORMATSII]

M. K. Gavurin *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 29–39 refs (See N68-27756 16-23)

Based partly on statistical decision theory, an estimate is made for quantitatively expressing the value of information. It is assumed that there is a given game $[X, Y, \chi]$, where the role of the first player belongs to nature; the second player is the worker, and $\chi(x,y)$ is his function of payment. Sets X and Y are assumed to be metric compacts. It is agreed that this distribution is determined on Borel sets of compacts. It is also assumed that the worker must select a solution prior to experiment p, that function p is known to him, and that he follows Bayes strategy. Conditions for the payoff function are stated, and information value and entropy values of the experiment are defined. M.G.J.

N68-27760# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORY OF ERROR OF RUNGE-KUTTA METHOD [TEORIYA POGRESHNOSTI METODA RUNGE-KUTTA]

A. A. Kurmit *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 40–56 refs (See N68-27756 16-23)

The error of the general fourth-order Runge–Kutta method is studied, and priori bound and posteriori bound theorems are obtained. In the example considered the error-bound given by the theory is compared with the actual error. Author

N68-27761# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

LIMIT THEOREMS FOR LARGE DEVIATIONS WHEN CRAMER'S CONDITION IS BROKEN. 1 [PREDEL'NYYE TEOREMY DLYA BOL'SHIKH UKLONENIY PRI NARUSHENII USLOVIYA KRAMERA. 1]

V. V. Petrov *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 57–79 refs (See N68-27756 16-23)

Some local limit theorems are proved for the big deviations of the sums of independent random variables. Both the limit theorem for the densities and the limit theorem for the lattice distributions are considered. The case of nonidentically distributed variables is also discussed. The conditions of the theorems obtained include a weakening of the Cramér's condition. Author

N68-27762# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF PROBLEM OF SCATTERING IN CERTAIN INFINITE REGIONS. 2 [ISSLEDOVANIYE ZADACHI RASSEYANIYA V NEKOTORYKH BESKONECHNYKH OBLASTYAKH. 2]

A. G. Ramm *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 80–88 refs (See N68-27756 16-23)

The resolvent kernel of the Laplace operator of the Dirichlet problem in certain unbounded domains is examined. Author

N68-27763# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT STABILITY OF UNDISTURBED MOTION OF SYSTEM OF THREE EQUATIONS IN ONE CRITICAL CASE [OB USTOYCHIVOSTI NEVOZMUSHCHENNOGO DVIZHENIYA SISTEMY TREKH URAVNENIY V ODNOM KRITCHESKOM SLUCHAYE]

Ye. T. Sofronov *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 89–98 refs (See N68-27756 16-23)

The problem of the stability of zero solution of the stationary system of three differential equations is investigated, when a characteristic equation has a three-fold root with one elementary denominator. Some sufficient conditions of nonstability and stability are obtained. Author

N68-27772# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE REPRESENTATION OF SIMPLE NUMBERS BY POLYNOMIALS FROM TWO UNKNOWNS [O PREDSTAVLENII PROSTYKH CHISEL MNOGOCHLENAMI OT DVUKH NEIZVESTNYKH]

D. N. Lenskoy *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 190–196 refs (See N68-27756 16-23)

An upper bound is found for the number $\pi(f_1, f_2, \ldots, f_k, N)$ of lattice-points of the square $1 \leq x < N$, $1 \leq y \leq N$, in which all polynomials $f_1(x, y)$, $f_2(x, y)$, (x, y) (having integral coefficients) simultaneously take prime values. Author

N68-27778# Illinois Univ., Urbana. Computer Sciences Dept.

EIGEN-VALUE PROBLEMS

Ahmed Sameh and Luke Han 4 Apr. 1968 59 p refs
(Contract AF 30(602)-4144)
(Rept.-258; Doc.-258; AD-668777)

The most used methods for solving algebraic eigenvalue problems are discussed in detail in this report. These methods are Jacobi's, Householder's and QR-algorithms. Attempts are made to adapt or even modify the algorithm to take advantage of parallel computations. Author (TAB)

N68-27897# Massachusetts Inst. of Tech., Cambridge. Operations Research Center.

GROUP THEORETIC ALGORITHMS FOR THE INTEGER PROGRAMMING PROBLEM 2: EXTENSION TO A GENERAL ALGORITHM

Jeremy F. Shapiro 11 Mar. 1968 39 p refs
(Contract DA-31-124-ARO(D)-209)
(TR-38; AD-668923)

The main result of this paper is a group theoretic algorithm (GTIP2) for the integer programming problem. This algorithm is an extension of an algorithm from an earlier paper (part I). The algorithm in part I solves a group optimization problem derived from a given integer programming problem. The optimal solution to the group problem thereby obtained is an optimal solution to the integer programming problem if it is feasible. Unfortunately, an optimal solution to the group problem may yield an infeasible integer solution. The algorithm GTIP2 of this paper is an extension of the method of part I when it fails. In particular, GTIP2 employs a search procedure to find an optimal solution to the integer programming problem. The extent of the search is bounded by procedures derived from a variety of relevant group problems which are solved by the algorithm of part I. There is a discussion of the class of problems for which GTIP2 is primarily intended and the relationship of GTIP2 to other algorithms is indicated. A numerical example and some partial computational results are included. Author (TAB)

N68-27898# Illinois Univ., Urbana. Coordinated Science Lab.

ON THE EQUIVALENCE OF REGULAR EXPRESSIONS

John P. Hayes Apr. 1968 31 p refs
(Contract DAAB07-67-C-0199; NSF GK-1663)
(R-374; AD-668872)

Some existing techniques for checking the equivalence of regular expressions are examined and their shortcomings discussed. A checking procedure based on the construction of regular equations is described. First, a set of transition or T-equations is obtained from the given expressions R and S. These are then converted to derivative or D-equations. Finally, a set of D-equations corresponding to the sum of R and S is constructed. It is shown that R = S if and only if the D-equations of the sum of R and S do not contain the empty string lambda. Upper bounds are determined for the number of equations involved in each step of the procedure. Unlike previously-described methods, neither the construction of the graphs nor the computation of derivatives is required. This technique is also applicable to extended regular expressions involving any Boolean operators. A modified procedure involving minimization of the D-equations of R and S is also discussed. R = S if and only if their respective minimized D-equations are isomorphic. Finally, it is shown that these equations lead to a canonical form for equivalent expressions. Author (TAB)

N68-28024# Pittsburgh Univ., Pa.

A GENERALIZATION OF HAAG'S THEOREM

L. Streit Feb. 1968 10 p refs
(Contract AT(30-1)-3829)
(NYO-3829-22) CFSTI: HC$3.00/MF$0.65

A generalization of the Haag theorem is presented. This generalization essentially consists in dropping not only locality but relativistic covariance altogether, in fact the notion of space (Euclidean versus e.g., lattice) need not be specified. NSA

N68-28218# Atomic Energy Establishment, Winfrith (England).

DRIFT CORRECTION OF BINARY CROSS-CORRELATION MEASUREMENTS

J. D. Cummins Oct. 1967 13 p refs
(AEEW-R-583) CFSTI: HC$3.00/MF$0.65

Drift correction of binary cross-correlation measurements is shown to be feasible at the expense of a longer recording time. The errors introduced to cross-correlation measurements for linear, quadratic, cubic, quartic and quintic drift laws are presented in graphical form. Author

N68-28230# United Kingdom Atomic Energy Authority, Harwell (England).

USING CUBIC SPLINES TO APPROXIMATE FUNCTIONS OF ONE VARIABLE TO PRESCRIBED ACCURACY

A. R. Curtis and M. J. D. Powell Nov. 1967 38 p refs
(AERE-R-5602) CFSTI: HC$3.00/MF$0.65

The intention of this paper is to present an algorithm to approximate a continuous function, $f(x)$, over a given range, $a \leq x \leq b$, by a cubic spline, $s(x)$, which deviates from $f(x)$ by not more than a prescribed accuracy, ϵ. It is presumed that $f(x)$ can be calculated for any x in the range, the approximation by a simpler function being required because each evaluation of $f(x)$ is laborious; therefore it is attempted to use few function values in obtaining the representation. The strategy is to refine an initial crude approximation iteratively by inserting extra knots where indicated by an error estimate, so the problem of estimating the magnitude of the error function is fundamental. It is demonstrated that a useful solution may be obtained by means of difference operators. The effect of function value errors is discussed, and some numerical examples are presented. Author (NSA)

N68-28240*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PLOT3D—A PACKAGE OF FORTRAN SUBPROGRAMS TO DRAW THREE-DIMENSIONAL SURFACES

R. Bruce Canright, Jr. and Paul Swigert Washington Jun. 1968 32 p refs

(NASA-TM-X-1598) CFSTI: HC$3.00/MF$0.65 CSCL 12A

PLOT3D is a package of FORTRAN subprograms to draw three-dimensional surfaces of the form $z = f(x,y)$. The function f and the bounding values for x and y are the input to PLOT3D. The surface thus defined by PLOT3D may be drawn after arbitrary rotations. Output is by off-line incremental plotter or on-line microfilm recorder. PLOT3D is completely described along with its limitations, possible future modifications, and poetential uses. Sample output and listings of the subprograms are included. Written entirely in FORTRAN IV, PLOT3D is readily adaptable to other hardware. Author

N68-28252*# Institute of Modern Languages, Inc., Washington, D. C.

THE PERTURBED GALERKIN METHOD AND THE GENERAL THEORY FOR NON-LINEAR EQUATIONS [VOZMUSHCHENNYY METOD GALERKINA I OBSHCHAYA TEORIYA PRIBLIZHENNYKH METODOV DLYA NELINEYNYKH URAVNENIY]

G. M. Vaynikko Washington NASA May 1968 34 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 7, no. 4, Jul.–Aug. 1967 p 723–751

(Contract NASw-1693)

(NASA-TT-F-11376) CFSTI: HC$3.00/MF$0.65 CSCL 12A

This article deals with the application of L.V. Kantorovich's general theory of approximate methods for the solution of non-linear equations. in this article an attempt is made to construct an analogous theory for nonlinear equations. Author

N68-28255*# Maryland Univ., College Park. Computer Science Center.

LOCAL MAPPING RELATIONS AND GLOBAL IMPLICIT FUNCTION THEOREMS

Werner C. Rheinboldt Feb. 1968 40 p refs

(Grants NsG-398; DA-ARO(D)-31-124-G676)

(NASA-CR-95370; TR-68-62) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The problem of determining global existence theorems for solutions y of operator equations $F(x,y) = z$ for fixed x,z, once local solvability conditions are known, was discussed. The problem was studied in the following abstract setting: Given a relation Φ between two topological spaces such that Φ behaves locally like a continuous mapping, determine information about the "global" behavior of Φ. The central condition assumed for Φ is a general continuation property derived from the so-called continuation method used in the solvability theory of operator equations. The abstract theory when applied to equations $Fy = x$, leads to a number of new global existence results for such equations including, as a special case, the well-known Hadamard–Levy theorem and one of its recent generalizations. For the case of implicit equations $F(x,y) = O$ in Banachspaces, the theory covers and extends the results obtained by Ficken for the continuation method. Author

N68-28281*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ON THE USE OF ALGEBRAIC METHODS IN THE ANALYSIS AND DESIGN OF MODEL-FOLLOWING CONTROL SYSTEMS

Heinz Erzberger Washington Jul. 1968 31 p refs

(NASA-TN-D-4663) CFSTI: HC$3.00/MF$0.65 CSCL 12A

This study gives an analysis of and offers design criteria for three configurations of model following. The three configurations studied are real model following, implicit model following or matching dynamics, and real model following with command inputs. It is assumed that model and plant are described by linear vector differential equations where the equations of the model may be of lower order than those of the plant. Algebraic tests are developed to determine under what conditions a feedback law exists that permits perfect following of the model by the closed-loop plant. The same set of tests is shown to be applicable to both real and implicit model following. This leads to the conclusion that real and implicit model following, although physically different, are mathematically equivalent if no unknown state disturbances or parameter variations occur during the control interval. However, the condition for perfect following with command inputs to the model contains an additional test not present in the first two configurations. If perfect following was shown to be possible, the control law that achieves it is calculated for the implicit model-following configuration. In the general case, this control law must generate both finite and impulse controls if the model is of lower order than the plant. A simple method of approximating the impulse control law to arbitrary accuracy is also given. The theory is illustrated with three examples, two of which are based on the lateral equation of motion of an aircraft. Author

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N68-28971# Space Data Corp., Phoenix, Ariz.

METEOROLOGICAL PROBE PWN-8B QUALIFICATION PROGRAM Final Report, 1 Jul. 1966–29 Feb. 1968

Bruce Bollermann and Robert L. Walker 28 Feb. 1968 56 p refs

(Contract AF 19(628)-5921)

(AFCRL-68-0132; AD-668545)

The meteorological probe PWN-8B has been developed, qualified and successfully flight tested for final standardization by the U.S. Air Force to make available a low cost meteorological sounding rocket system for operational use. The major components of the probe system include a small solid-propellant rocket motor, a nonpropulsive dart which contains the payload, a launcher and a ground-based test set. The system has been designed for launches at remote sites as well as at established missile ranges. Atmospheric temperature and wind data are obtained with this probe to an altitude of 200,000 feet. Author (TAB)

N68-27062# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ANALYSIS OF DISPERSION OF HORIZONTAL OSCILLATIONS OF THE WIND DIRECTION

Ye. L. Genikhovich and V. P. Gracheva *In its* Questions of Atmospheric Diffusion and Air Pollution 27 Sep. 1967 p 15–22 refs (See N68-27050 16-13)

Dependence of dispersion of meteorological quantities on internal and external intervals of averaging is examined on the basis of theoretical considerations. Absolute quantities of wind direction dispersion and their dependence on meteorological conditions and on the period averaging are obtained. Author

N68-27063# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE QUESTION OF HORIZONTAL SCATTERING OF IMPURITY IN THE ATMOSPHERE

V. S. Yeliseyev *In its* Questions of Atmospheric Diffusion and Air Pollution 27 Sep. 1967 p 23–29 refs (See N68-27050 16-13)

The method of determining the coefficient of horizontal diffusion according to a visible outline of smoke from industrial smoke stacks is discussed, and results are given of the calculation and analysis of parameters characterizing horizontal diffusion according to data of aircraft observations of the smoke torch of the Shchekino power station. A comparison is made of obtained data with characteristics of horizontal diffusion by Sutton. Author

N68-27092# Travelers Research Center, Inc., Hartford, Conn.

BALLISTIC WINDS STUDY Quarterly Report, 1 Sep.–30 Nov. 1967

Frederick P. Ostby, Jr. May 1968 30 p
(Contract DAAB07-67-C0296)
(ECOM-0296-3; QR-3; AD-668922)

Some preliminary analyses were derived from the CRAM objective analysis program. The program has been generalized so that various grid intervals may be conveniently tested. There also has been a modification which will permit use of a cathode-ray tube to generate maps of the program output. Two sets of analyses were made. One used a 10-km grid interval while the other used a finer 5-km grid interval. The finer grid mesh analysis fits the data more closely than the 10-km grid. Author (TAB)

N68-27108# Air Weather Service, Offutt AFB, Nebr. Air Force Global Weather Central.

A STUDY OF AMPLITUDE RESPONSE AS A FUNCTION OF WAVELENGTH FOR THREE COMMONLY USED SMOOTHING FILTERS

Harold B. Hart Mar. 1968 24 p refs *Its* Tech. Study No. 1
(AD-669140)

The purpose of this study is to compare the amplitude responses of three filters when applied to a one-dimensional wave as the smoothing element index is varied so that a clear picture of the characteristics of each filter emerges. By examining the response curves, the reader can select the proper filter as applied the gridded meteorological fields. The value of the smoothing element index to produce the desired response can be selected. Author (TAB)

N68-27126# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

PREPRINTS OF THE CONFERENCE ON UNGUIDED ROCKET BALLISTICS METEOROLOGY, ADDENDUM

Jan. 1968 212 p refs Conf. held in Univ. Park, N. Mex., 31 Oct.–2 Nov. 1967
(AD-667928)

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N68-27131# Michigan Univ., Ann Arbor. Dept. of Meteorology and Oceanography.

A SMOKE ROCKET TECHNIQUE FOR DAYTIME WIND MEASUREMENTS TO THREE THOUSAND FEET

Gerald C. Gill, Albert W. Stohrer, and Timothy L. Sweeney *In* White Sands Missile Range Preprints of the Conf. on Unguided Rocket Ballistics Meteorology, Addendum Jan. 1968 p 153–183 refs (See N68-27126 16-20)
(Contract DA-29-040-AMC-1764(E))
(Publ.-132)

A small, reuseable rocket is fired almost vertically to heights in excess of 3000 feet above ground, producing a visible tracer or smoke plume from ground to near apogee. The spent rocket returns to ground by parachute. The micron-sized tracer particles, having an estimated fall rate of less than 10 feet per hour move with the wind responding to all changes in speed and direction. By taking simultaneous stereoscopic pictures of the smoke plume at 2 second intervals the movement of the plume at all levels can be followed with surprising accuracy. By using calibrated aerial type reconnaisance cameras and precision techniques simultaneous wind speed and direction measurements can be made with errors of less than 2 feet per second at all levels up to 3000 feet above ground. Author

N68-27132# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

COMPARISON RESULTS FROM RADAR TRACKER (T-9) AND CONTRAVES PHOTO-THEODOLITE

Ralph L. Butler and James K. Hall *In its* Preprints of the Conf. on Unguided Rocket Ballistics Meteorology, Addendum Jan. 1968 p 185–209 refs (See N68-27126 16-20)

Radar tracker (T-9) measurements were compared with Contraves photo-theodolite values which were taken as the standard. In the analysis, 100-, 250-, 350-, 500- and 750-foot layer mean winds were used for each of six (nine-minute duration) pilot balloon observations. Slant range differences at 20-second intervals were computed and plotted as were histograms of speed differences and x and y component velocity differences. Mean direction and speed errors are tabulated. Tests were conducted under very light wind conditions. Author

N68-27265 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.

METEOROLOGICAL DATA. VOLUME 80, NO. 3: DAILY ALTITUDE MAPS OF THE 100 MB LEVEL AND THE 50 MB LEVEL AS WELL AS MONTHLY MEAN MAPS FOR 1967

[METEOROLOGISCHE ABHANDLUNGEN. BAND LXXX, HEFT 3: TAEGLICHE HOEHENKARTEN DER 100-MB-FLAECHE UND DER 50-MB-FLAECHE SOWIE MONATLICHE MITTELKARTEN FUER DAS JAHR 1967. TEIL III, 3. VIERTELJAHR] Quarterly Report

Regina Kirch, Barbara Kriester, Karin Labitzke, Wolfgang Roeder, Richard Scherhag et al 1967 215 p In GERMAN
(QR-3, Pt. 3)

Presented are atmospheric circulation maps for the third quarter of 1967. Daily altitude maps for the 100 mb level and the 50 mb level are shown as well as the monthly mean variations for the Northern Hemisphere. Transl. by G.G.

N68-27266 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.

METEOROLOGICAL DATA. VOLUME 76, NO. 12: RESULTS OF THE ASCENTS OF THE RADIOSONDE STATION, BERLIN-TEMPELHOF, OF THE INSTITUT FUER METEOROLOGIE UND GEOPHYSIK OF THE FREIE UNIVERSITAET BERLIN, DECEMBER 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVI, HEFT 12: ERGEBNISSE DER AUFSTIEGE DER RADIOSONDENSTATION, BERLIN-TEMPELHOF, DES INSTITUTS FUER METEOROLOGIE UND GEOPHYSIK DER FREIEN UNIVERSITAET BERLIN IM JAHRE 1967, DEZEMBER]

Richard Scherhag et al 1968 111 p refs In GERMAN; ENGLISH summary
CFSTI: $3.00

The detailed results of the radiosonde ascents performed by the aerological station of the Institut für Meteorologie und Geophysik der Freien Universität Berlin are presented. Extreme and mean values of the temperature, geopotential, pressure, wind data, refractivity, density, pseudopotential temperature and velocity of sound for all standard pressure surfaces and for several height levels, the tropopause and the freezing level were extracted. Author

N68-27328# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

A DATA REDUCTION TECHNIQUE FOR METEOROLOGICAL WIND DATA ABOVE 30 KILOMETERS

E. P. Avara and B. T. Miers Dec. 1967 29 p refs
(ECOM-5168; AD-667918)

The FPS-16 tracking systems superimpose undesired oscillations on the real position data resulting in rapidly fluctuating successive position points which are physically unrealistic. The frequency response is given and the data are corrected by a method derived by Eddy et al. Undesired high frequency oscillations are effectively eliminated and successive wind profiles show good continuity. Author (TAB)

N68-27339# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.

WEATHER SATELLITE OBSERVATIONS AND THEIR EVALUATION. THE EUROPEAN WEATHER PICTURE. PART 3: JULY–AUGUST 1966 [WETTERSATELLITENBEOBACHTUNGEN UND IHRE AUSWERTUNG. DAS EUROPAEISCHE WETTERBILD, 1966. TEIL 3: JULI–AUGUST 1966]

Ingrid Haupt et al 1967 188 p refs In GERMAN; ENGLISH summary
CFSTI: HC$3.00/MF$0.65

This volume gives the weather-satellite observations of the European-Atlantic area for July and August 1966. Part I contains some remarks on the first Soviet weather-satellite COSMOS 122. Some results of it will be shown, interpreted and compared with American weather-satellite observations of ESSA 1 and NIMBUS 2. Part II presents the daily publication "Das europäische Wetterbild" in form of cloud-mosiacs, short descriptions and special tables. In part III the most significant orbital data of ESSA 2 and NIMBUS 2 for the corresponding two-months period are published. Author

N68-27677# International Geophysical Year World Data Center A, Washington, D. C.

METEOROLOGICAL ROCKET NETWORK FIRINGS **Meteorology Data Report**

Aug. 1967 224 p *Its* Vol. 4, No. 8
GPO: $3.00

Wind and temperature measurements from all available meteorological sounding rocket firings are presented, along with computed values for pressure, density, and speed of sound. Local radiosonde observations nearest the time of firing are included. Author

N68-28065*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.

METEOROLOGICAL CONDITIONS ASSOCIATED WITH THE OCCURRENCE OF NOCTILUCENT CLOUDS [O METEOROLOGICHESKIKH USLOVIYAKH POYAVLENIYA SEREBRISTYKH OBLAKOV]

Yu. V. Kurilova NASA May 1968 6 p refs Transl. into ENGLISH from Meteorol. Issled. (Moscow), no. 12, 1966 p 101–105
(Contract NASw-1693)
(NASA-TT-F-11524) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The results of a detailed analysis of the synoptic maps in the periods of the noctilucent cloud appearance in 1963–1964 over Western Siberia were presented. The conclusion on the connection of noctilucent clouds with anticyclonic conditions is confirmed. The explanation of this connection, based on the account of the appearance in the troposphere and the propagation upward of the inner gravitational waves is suggested. The formation of these waves is favored by the presence of the anticyclone. The paper gives an estimation of the possible energetic contribution from the gravitational waves into the upper layers: the energy streams appear significant. The range of gravitation wave frequencies with the wave characteristics in noctilucent clouds was compared with the account of the data on the general spectrum of meteorological fields. Author

N68-28066*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.

DETERMINATION OF SPATIAL COORDINATES OF NOCTILUCENT CLOUDS [OPREDELENIYE PROSTRANSTVENNYKH KOORDINAT SEREBRISTYKH OBLAKOV]

M. A. Dirikis, S. V. Yevdokimenko, and Yu. L. Frantsman NASA May 1968 7 p refs Transl. into ENGLISH from Meteorol. Issled. (Moscow), no. 12, 1966 p 47–51
(Contract NASw-1693)
(NASA-TT-F-11521) CFSTI: HC$3.00/MF$0.65 CSCL 04A

For determination of spatial coordinates of noctilucent clouds, measurements of cloud details and of reference stars in each photograph have been made by means of a measuring microscope. For all reductions a calculation program was compiled for the Latvian State University electronic computer BESM-2M. First results of these calculations are given in this article. The horizontal velocities of some measured details are very great—up to 170 m/sec. Their movement is directed in most cases to the southwest. The velocities of the vertical movements are also very different. In some cases they reach 20 m/sec and more. Author

N68-28099*# Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.

SELECTING THE CONDITIONS FOR OBSERVING NOCTILUCENT CLOUDS FROM THE EARTH'S SURFACE AND FROM SPACE SHIPS [K VYBORU USLOVIY NABLIUDENIYA SEREBRISTYKH OBLAKOV S ZEMNOY POVERKHNOSTI I S KOSMICHESKIKH KORABLEY]

G. V. Rosenberg NASA May 1968 4 p refs Transl. into ENGLISH from Meteorol. Issled. (Moscow), no. 12, 1966 p 30–32
(Contract NASw-1693)
(NASA-TT-F-11519) CFSTI: HC$3.00/MF$0.65 CSCL 04B

Formulas were given for the contrast and brightness of the cloud against the sky background. These formulas are discussed for the conditions corresponding to the site of the observer on the earth's surface, in the space ship, at the level (by day) of 60–70 km. It is stated that pearl and other stratospheric clouds situated lower than 30 km become well visible if they are observed from a space ship against the background of the early dawn. The paper shows that this method is not applicable to noctilucent cloud observations, as the contrast constitutes only fractions of a percent. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N68-27803*# Clemson Coll., S. C.
USE OF STELLAR REFERENCES IN SPACE NAVIGATION
[1966] 5 p Presented at the IEEE State Conv., Columbia, S. C., 1966
(Grant NGR-41-001-008)
(NASA-CR-82554) CFSTI: HC$3.00/MF$0.65 CSCL 17G

The required accuracy of seconds of arc which the theodolite offers for Apollo and post-Apollo manned flights is discussed, and the requirements for midcourse navigation corrections for interplanetary trajectories are delineated. It is pointed out that any star offers a convenient reference for travel in our solar system, and use of stellar references obviates gyros with their attendant disadvantages. Ordinary optics employing the optical lever arm with a photomultiplier sensor gives resolution of seconds of arc. After in-phase and quadrature demodulation of the star sensor signals, coordinate transformation gives the position errors in pitch, roll, and yaw. Since these errors already have uncertainties of the order of one arc second, the Weiner filter by a Bode–Shannon realization was used in the linear mode of the system to correct for drift and other small errors. A digital simulation of the signal process showed that the cross-coupling between pitch, roll, and yaw would be less than 25% if the sensor's field of view is limited to 900 square degrees around their nominal aimings of +45°, and −45°. The use of air bearings instead of gimbals also permitted the close proximity desired for maximum torque and application of torque independent of spacecraft coordinates. A.L.

N68-28238*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
NAVIGATION AND GUIDANCE SYSTEMS PERFORMANCE FOR THREE TYPICAL MANNED INTERPLANETARY MISSIONS
Flora B. Lowes and Thomas B. Murtagh Washington Jul. 1968 39 p refs
(NASA-TN-D-4629) CFSTI: HC$3.00/MF$0.65 CSCL 17G

The navigation and guidance systems performance for manned interplanetary flight is evaluated for three representative missions: a 1972 Venus flyby mission, a 1975 Mars flyby mission, and a 1977 Mars orbital mission. The navigation system has both Earth-based radar and onboard tracking capabilities for updating position and velocity estimates for a spacecraft and an unmanned probe. Fixed-time-of-arrival and variable-time-of-arrival guidance logic is used in the guidance system to compute velocity corrections and target dispersions. From the performance evaluation for the three missions considered, arrival accuracies and propellant requirements can be predicted for the spacecraft and probe in the three types of missions presented or in similar interplanetary missions. Author

N68-28262*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RADIOMETRIC MEASUREMENTS OF THE EARTH'S INFRARED HORIZON FROM THE X-15 IN THREE SPECTRAL INTERVALS
Antony Jalink, Jr., Richard E. Davis, and Dwayne E. Hinton Washington Jul. 1968 59 p refs
(NASA-TN-D-4654) CFSTI: HC$3.00/MF$0.65 CSCL 17G

Experimental data of the earth's horizon in three spectral intervals, 0.8 to 2.8 μm, 10 to 14 μm, and 14 to 20 μm, have been obtained by using the X-15 research airplane. The resolution (field of view) of the data at the tangent point is approximately 2 kilometers, and the spatial position of the horizon profile is known to within 4 kilometers. The 14 to 20 μm interval was shown to be the best spectral interval for horizon sensing because it exhibits the least variance at adequate radiant intensity. The 0.8 to 2.8 μm and 10 to 14 μm spectral intervals do not appear suitable for accurate horizon sensing because they are sensitive to low-altitude meteorological changes. The experimental data obtained verified, within experimental accuracy, the theory used to predict the far infrared radiant energy due to carbon dioxide. The use of theory for spectral regions where high-altitude water-vapor data are required is questionable because no mixing-ratio information is available. The single-scattering theory cannot predict accurately the radiant energy in the near infrared region (<3.0 μm). Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N68-27003*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A NUCLEAR THERMIONIC SPACE POWER CONCEPT USING ROD CONTROL AND HEAT PIPES
John L. Anderson and Edward Lantz Washington 1968 37 p refs Presented at the Am. Nucl. Soc. Ann. Meeting, Toronto, 9–13 Jun. 1968
(NASA-TM-X-52446) CFSTI: HC$3.00/MF$0.65 CSCL 18E

A nuclear reactor space power system using out-of-pile thermionic diodes, heat pipes, and a dual central rod type of reactivity control was investigated. Emphasis is on the neutronic aspects and general feasibility of the concept. In this concept heat is transferred from the reactor core to the thermionic diodes by layers of radial heat pipes stacked alternately with slabs of fuel. For this out-of-pile concept, which would supply 130 kWe, the reactor can be considerably smaller than the equivalent reactor with in-pile diodes, when used with a shadow shield. Author

N68-27049*# Picatinny Arsenal, Dover, N. J. Explosives Lab.

A LARGE CONTAINMENT CAPSULE FOR NUCLEAR REACTOR IRRADIATION OF EXPLOSIVE MATERIALS

Louis Avrami, Everett Dalrymple, and Frank Schwartz Apr. 1968 103 p refs
(NASA Order SNC-3)
(NASA-CR-95102; PA-TR-3673; AD-668674) CFSTI: HC $3.00/MF $0.65 CSCL 18J

The design and development of a large explosive containment capsule for the irradiation of up to 80 grams of explosive materials is described. The capsule will fully protect its surroundings, e.g., the core of a nuclear reactor, if its explosive content detonates. The minimum safety factor of two was used. The capsule contains provisions for the containment of gases produced by detonation or burning of the explosive material and the minimizing of any shock wave propagated outside the capsule. Also, provisions are made to monitor pressure or gas evolution and the temperature of the test material during irradiation. Dynamic pressure pulse and stress-strain measurement tests were conducted and are described. Analytical calculations were made for comparison with experimental data, first to determine the validity of the calculations and then to obtain information on configurations not actually tested. Author (TAB)

N68-27200# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.

IRRADIATION OF TUBULAR URANIUM DIOXIDE FUEL ELEMENTS IN THE HWCTR

T. H. Crim, G. R. Cole, and W. G. Holmes Nov. 1967 78 p refs
(Contract AT(07-2)-1)
(DP-995) CFSTI: HC $3.00/MF $0.65

Irradiation of 97 Zircaloy-clad urania tubes in the Heavy Water Components Test Reactor indicated that tubes with compacted powder cores made by the best available techniques will operate satisfactorily in a full scale heavy-water-moderated power reactor to peak exposures of at least 20,000 MWD/MTU and peak thermal ratings ($\int_{Ts}^{Tc} k d\theta$) of 30 watts/cm. Examination of 45 tubes irradiated in the HWCTR indicated that: less than 10% of the fission gas produced during irradiation was released in fuel tubes operating at low $\int k d\theta$; the fractional release increased sharply with the onset of columnar grain growth in the urania core; release of nitrogen from impurities in fused urania was substantially reduced by outgassing the urania at high temperature in vacuum or hydrogen before irradiation; the outer sheath wrinkled in tubes with relatively low-density cores [82 to 87% of theoretical density (TD)] operated at $\int k d\theta$ of 40 to 45 watts/cm; and tubes compacted to 90% TD did not wrinkle when irradiated at 50 watts/cm. Author (NSA)

N68-27218 California Univ., Berkeley.

A NEW INTERPRETATION OF PULSED NEUTRON EXPERIMENTS IN A REFLECTED REACTOR

Alan Edward Waltar (Ph.D. Thesis) 1966 140 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-8665

A new interpretation of pulsed-neutron reactivity measurements in reflected reactors has been developed and tested. The theory employs the Cohn model to describe the system, and provides an expression for reactivity which may be evaluated either in terms of core data or reflector data. Solving the system equations for a delta-function source results in an expression for the neutron density in either core or reflector. The expression for reactivity consists of two terms corresponding to the two characteristic prompt modes of the system. One is identical to that originally derived by Gozani, and the other arises as the direct result of including the reflector in the analysis. Experiments performed on the AGN-201 reactor were made to test the theory and rather conclusive verification was obtained. Dissert. Abstr.

N68-27225# Battelle Memorial Inst., Columbus, Ohio.

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER THROUGH DECEMBER, 1967

Donald L. Keller 1 Jan. 1968 68 p refs
(Contract W-7405-ENG-92)
(BMI-1826)

A study of mixed UN-PuN fuels is to conducted for uses in thermal reactor applications. Effects involving preparation of materials, property determinations, irradiation studies, and supportive studies are reported. The casting of uranium-plutonium carbonitrides is also being studied. NSA

N68-27231*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ARE GAS-CORE NUCLEAR ROCKETS ATTAINABLE?

Robert G. Ragsdale [1968] 9 p refs Presented at the 4th Propulsion Joint Specialist Conf., Cleveland, 10-14 Jun. 1968 Sponsored by the Am. Inst. of Aeron. and Astronautics
(NASA-TM-X-52435) CFSTI: HC $3.00/MF $0.65 CSCL 21F

In order to evaluate an advanced nuclear engine concept, it must be compared with other concepts and with engine requirements. This paper describes a way to make such comparisons for open-cycle, gaseous-fueled nuclear rocket engines. Engine requirements are expressed in terms of two parameters. One parameter is the fraction of the engine cavity volume that is occupied by gaseous nuclear fuel. The other parameter is the ratio of mass flow rates, hydrogen-to-uranium, that is entering (and, therefore, leaving) the engine. These parameters are used to define engine performance goals and to compare experimental data for existing concepts. Author

N68-27566# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Nuclear Labs.

THERMAL NEUTRON ABSORPTION CROSS SECTIONS OF ZIRCALOY-2, COPPER AND ALUMINUM

A. Okazaki and R. E. Green Apr. 1968 20 p refs
(AECL-3073) CFSTI: HC $3.00/MF $0.65

The 2200 m/s absorption cross-sections of Zircaloy-2, copper and aluminum were determined relative to that of gold by measuring the relative reactivity effects of samples placed in a well-moderated region of the ZED-2 reator. The following results were obtained, assuming σ_o (gold) = 98.8 barns: σ_c (Zircaloy-2) = 0.208±0.002 barns, σ_o (Copper) = 3.71±0.06 barns, and σ_o Aluminum) = 0.234±0.005 barns. These are in agreement with those of other workers. Author

N68-27636# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).

NUCLEAR FUEL PARTICLES CONSISTING OF METAL-CARBIDE-SATURATED COKE PARTICLES [KERNBRENNSTOFFPARTIKELN AUS METALLKARBIDGETRAENKTEN KOKSTEILCHEN]

H. Bildstein, K. Knotik, and G. Stolba 1967 13 p refs In GERMAN Submitted for publication
(SGAE-CH-49/1967) CFSTI: HC $3.00/MF $0.65

A method for preparing carbon-metal carbide particles, particularly carbon-uranium carbide particles, is described. The method makes use of coke granules obtained as a by-product of petroleum cracking. A thermal process is used to impregnate the granules with the metal carbide. Because of their favorable porosity, these granules are well suited for the production of high-temperature nuclear reactor fuels. Transl. by K.W.

N68-27681# Argonne National Lab., Ill.

REACTOR DEVELOPMENT PROGRAM Progress Report, Jan. 1968

C. L. Chernick and A. Glassner 27 Feb. 1968 165 p refs
(Contract W-31-109-ENG-38)
(ANL-7419) CFSTI: HC $3.00/MF $0.65

Reactor fuels and their elements, several types of liquid metal cooled reactors, fission products, and irradiation effects on various reactor materials were investigated. Technitium determination was made in irradiated U-Pu-Zr, and enrichment effects and burnup rates were studied. Sodium corrosion of some jacket alloys, impurities in liquid sodium, and effect of sodium vapor on electrical insulators were investigated. Fuel subassemblies, control rods, and fuel cycles were studied for the Experimental Breeder Reactor 2. Thermal diffusivities for plutonium and uranium carbides and neutron cross sections in uranium and vanadium isotopes were determined. NSA

N68-27966# Atomic Power Development Associates, Inc., Detroit, Mich.

THERMAL POWER CALIBRATION OF THE ENRICO FERMI REACTOR

R. C. Callen and H. J. Allgeier Feb. 1968 51 p refs
(APDA-NTS-16) CFSTI: HC$3.00/MF$0.65

Experiments of thermal power calibration of the Enrico Fermi reactor are described. Preliminary experiments are required to examine temperature detector response and determine system dissipative heat losses. Three determinations are made of reactor power at levels between 85 and 100 MW. The technique employed is to determine the power removed by the feedwater-steam system in the form of superheated steam; this is corrected for extraneous power sources to obtain reactor power. Errors resulting from experimental and operational sources are discussed and comparison of results with those of a nuclear calibration is presented. Author (NSA)

N68-27968# Brookhaven National Lab., Upton, N. Y.

TOTAL AND FISSION CROSS SECTIONS OF ^{239}Pu

H. Derrien, J. Blons, C. Eggermann, A. Michaudon, D. Paya et al [1966] 22 p Transl. into ENGLISH from STI/PUB-140, Vol. 2 Rept. Presented at the IAEA Conf. on Nucl. Data Reactors, Paris, 17–21 Oct. 1966
(BNL-TR-197; STI/PUB-140, V. 2) CFSTI: HC$3.00/MF$0.65

The neutron fission and total cross sections of ^{239}Pu were measured, and the resonances were identified up to 442 eV. Resonance parameters were obtained by shape analysis using a method of least squares in which the theoretical function is a sum of Breit–Wigner formulas for a level that is broadened by the Doppler effect. A complete set of resonance parameters was obtained up to 250 eV; beyond 250 eV only values of Γ and $2g\Gamma$ could be obtained. NSA

N68-28008# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria). Reaktorzentrum.

ALTERATIONS OF MATERIAL CHARACTERISTICS BY REACTOR RADIATION [AENDERUNGEN VON MATERIALEIGENSCHAFTEN DURCH REAKTORBESTRAHLUNG]

E. Tutschek and P. Koss 1968 29 p refs In GERMAN Submitted for publication
(SGAE-M-15/1968) CFSTI: HC $3.00/MF $0.65

Construction and operation of a notch impact apparatus designed to test the strength of irradiated samples is described. The apparatus permits tests in the temperature range from −150° to +250°C with a tolerance of ±3°C. Both automatic and manual temperature controls are provided. A radiative heat chamber is used to bring the samples to the desired temperature. The mechanism for transporting the samples, shielding arrangements, and initial results of Charpy tests on carbon steel samples are briefly discussed. Transl. by K.W.

N68-28009# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).

COATING OF NUCLEAR FUEL PARTICLES WITH PYROCARBON IN A VORTEX BED [ZUR BESCHICHTUNG VON KERNBRENNSTOFFTEILCHEN MIT PYROKOHLENSTOFF IM WIRBELBETT]

F. Mucha and P. Koss 1968 41 p refs In GERMAN
(SGAE-M-16/1968) CFSTI: HC $3.00/MF $0.65

Experiments were conducted to determine the effects of methane concentration, flux rate in the reaction zone, and bed surface geometry on the characteristics of the deposited pyrolytic carbon coatings, taking into account bed temperature, reaction rate, macro- and microgeometry of the vortex bed, and density and diameter of the particles. The experiments were conducted in a resistance-heated high-temperature furnace. Argon was used as the carrier and fluidization gas. Two types of spherical particles were used: pure, high-density UC_2, and precoated, low-density UC_2. Crystal size, microhardness, microstructure, and density of the coatings were also measured. Transl. by K.W.

N68-28010# General Electric Co., Sunnyvale, Calif. Advanced Products Operation.

TURBULENT VELOCITY DISTRIBUTION IN A ROD BUNDLE

D. J. Bender, D. M. Switick, and J. H. Field Oct. 1967 35 p refs
(Contract AT(04-3)-189)
(GEAP-5411) CFSTI: HC$3.00/MF$0.65

A method to determine the two-dimensional velocity distribution for turbulent, constant property single-phase flow through an infinite triangular rod bundle is presented. Turbulent momentum transport is directly calculated via a mixing length theory based on actual flow geometry. The velocity solution vector is determined by iteration between the momentum equation and the definition of turbulent momentum diffusivity. Correlation of the results shows the method to be consistent with experimental data and preferable to other analytic methods investigated. However, more detailed experimental data are necessary to demonstrate the general validity of the method. VELVET, a digital computer code to perform the required calculations, has been programmed for the General Electric 635 Data Processing System. Author

N68-28011# General Electric Co., Sunnyvale, Calif. Advanced Products Operation.

SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM Quarterly Report, Aug.–Oct. 1967

Dec. 1967 135 p refs
(Contract AT(04-3)-189)
(GEAP-5541; QR-24) CFSTI: HC$3.00/MF$0.65

Reactor fuel elements and their burnup were considered for sodium-cooled fast reactors; and attention was given to fission product measurements in irradiated stainless steel clad plutonium oxide-uranium oxide fuel rods. Corrosive effect of sodium on these fuel rods, as well as the radiation effects on swelling and tensile properties were discussed. Fuel pin irradiation studies were reported, and the reactor experimental facilities was described. Attention was also given to coolant loss accidents in liquid sodium, effects on fuel temperature of sodium loss during coolant flow, and vibration testing of induced sodium flow. Hastelloy, Incoloy 800, and stainless steels were considered as cladding materials, including fuel cladding failures and economic considerations, effects of neutron irradiation, and resultant tensile properties. NSA

N68-28013# Atomic Energy Establishment, Winfrith (England). Reactor Development Div.

A COMPARISON OF THE ACCURACY OF SOME CORRELATIONS FOR BURNOUT IN ANNULI AND ROD BUNDLES

P. G. Barnett Jan. 1968 34 p refs
(AEEW-R-558) CFSTI: HC$3.00/MF$0.65

An earlier compilation of burnout data for annuli and rod bundles is up-dated. A comparison is made of the accuracy with which five correlations for burnout in annuli predict the compiled annulus data; one correlation is found to be significantly better than the rest when the data are viewed as a whole. The accuracy with which this correlation, and two of the other correlations, also predict the rod bundle burnout data is compared; the same correlation is again found to be the more likely to give accurate predictions. The implication of these observations is that it may be possible to make considerable savings in the cost of experimental and assessment work on rod bundles by studying their equivalent annuli. Author (NSA)

N68-28016# Instituut for Atomenergi, Kjeller (Norway).

CROSS SECTIONS OF SOME (n,p) AND (n,α) REACTIONS INDUCED BY REACTOR FAST NEUTRONS

E. Steinnes Dec. 1967 15 p refs
(KR-123)

Some (n,p) and (n,α) reactions induced by reactor fast neutrons in elements of medium and high atomic number were studied by means of radiochemical separation methods. The previously unreported cross sections of the reactions ^{81}Br(n,p)^{81m}Se, ^{81}Br(n,p)^{81}Se and ^{106}Cd(n,p)^{106}Ag were found to be (12.0 ± 0.4) $\cdot 10^{-2}$mb, (1.2 ± 0.3) $\cdot 10^{-2}$mb, and 2.7 ± 0.2 mb, respectively. For the reaction ^{133}Cs(n,α)^{130}I, the present result (2.7 ± 0.6) $\cdot 10^{-3}$mb is significantly higher than previously published values. As the monitoring reaction, ^{27}Al(n,α)^{24}Na was used. Author (NSA)

N68-28018# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

THE NEUTRON DIFFUSION PARAMETER MEASUREMENTS OF GRAPHITE OF THE ANNA REACTOR

J. Chwaszczewski, A. T. Mikulski, and K. Dybowski 1967 23 p refs
(INR-P-853/IXA/PR)

Measurements of the parameters $\langle \Sigma_a \vartheta \rangle$ and D were made in the graphite of the ANNA reactor by the pulsed neutron source method and based on the determination of the decay constant for few space dependent distributions of higher harmonics. The results, $\langle \Sigma_a \vartheta \rangle = 79 \pm 3$ per sec and $D = (211 \pm 5) \times 10^3$ cm^2/sec for $\rho = 1.7$ g/cm^3 and temperature of 20 ± 4°C, are in good agreement with previous measurements, and confirm that the ANNA graphite meets the generally accepted standards of nuclear grade graphite. Author (NSA)

N68-28027# Los Alamos Scientific Lab., N. Mex.

FISSION DISTRIBUTION TECHNIQUES FOR ROVER REACTORS

Herbert H. Helmick and John D. Orndoff [1967] 4 p Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-ENG-36)
(LA-DC-9412; CONF-680601-7) CFSTI: HC$3.00/MF$0.65

The technique used to obtain thousands of sampling measurements of fission distribution in a Rover reactor is described. A plot of the ratio of two fission distributions measured in the Phoebus 2A reactor is presented. One distribution was made with the reactor control drums rotated out 115° from full shutdown and the second profile had the drums at 95°. NSA

N68-28030# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

STRETCH: A COMPUTER PROGRAM FOR PREDICTING COATED-PARTICLE IRRADIATION BEHAVIOR, MODIFICATION 4, DECEMBER 1967

J. W. Prados and T. G. Godfrey Apr. 1968 55 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2127) CFSTI: HC$3.00/MF$0.65

A computer program for calculating the expected operating lifetimes of pyrolytic-carbon-coated fuel microspheres under irradiation is described. The coating consists of a porous inner layer, which provides volume for fuel swelling and fission-gas release, and a high-density outer layer which serves as a pressure vessel. Anisotropic mechanical behavior and irradiation creep in the outer pyrolytic-carbon coating can be taken into account in the calculations. A listing of the FORTRAN IV source program, instructions for supplying input data, and sample output data are provided. Author (NSA)

N68-28036# Scripta Technica, Inc., Washington, D. C.

CONCEPT OF THE "SAWA" AND "WARS" BOILING SALT REACTORS

M. Taube, A. Kowalew, S. Poturaj-Gutniak, and M. Mielcarski [1967] 7 p refs Transl. into ENGLISH from Kernenergie (Dresden), No. 10 [1967] p 184–186
(ORNL-TR-1855) CFSTI: HC$3.00/MF$0.65

Boiling reactors using salts as nuclear fuel and with direct cooling may have a special role in the development of future nuclear power. A concept for two such reactors is presented. Their characteristics and some of their properties are compared mutually as well as with fast reactors utilizing non-boiling molten salts as fuel. Author (NSA)

N68-28048# Oak Ridge National Lab., Tenn.

INFLUENCE OF NEUTRON DATA IN THE DESIGN OF OTHER TYPES OF POWER REACTIONS

A. M. Perry 8 Mar. 1968 24 p refs Presented at the 2d Conf. on Neutron Cross Sect. and Technol., 4–7 Mar. 1968, Washington, D. C.
(Contract W-7405-ENG-26)
(ORNL-TM-2157; CONF-680307-28) CFSTI: HC$3.00/MF$0.65

The effects of cross-section uncertainties on estimates of breeding performance and of power cost for a molten-salt reactor are shown to be small. Uncertainty in breeding ratio due to cross-section uncertainties is less than ±0.02, and the uncertainty in power costs is less than ±0.03 mills/kwhr(e). Similarly small effects are shown for the high-temperature gas-cooled reactor. The need for further refinements in nuclear data is related primarily to the calculation of temperature coefficients of reactivity. Author (NSA)

N68-28049# Oak Ridge National Lab., Tenn.

ENTRAINED FLUIDIZED BED SYSTEM FOR PYROLYTIC CARBON COATING OF MICROSPHERES

H. J. Flamm Apr. 1968 39 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2113) CFSTI: HC$3.00/MF$0.65

A system for pyrolytic carbon coating of microspheres, in which particulate solids are entrained by an upward flowing gas stream and conveyed through a chimney concentric to this stream, was investigated in search of simple, economical, and potentially large-scale processes. The solids are disentrained above the chimney and return to an annular section external to the chimney for transient storage and reentrainment from the lower section, which is tapered toward a single gas inlet. The reaction zone remains independent of bed volume or height changes. Smooth conveying was demonstrated over a wide range of conditions in transparent models at room temperature, using glass beads, iron shot, and lead shot of various sizes as substitute materials and air as the entrainment medium. Slugging or bubbling was never observed. Contrary to fluidized-bed technology, in which the gas flow required for incipient fluidization increases as the square of the particle diameter, conveying rates in the described system increased with the particle diameter for a given gas flow. Based on the room-temperature model studies, a high-temperature entrained-bed system was built to adapt to an existing fluidized-bed furnace system. Pyrolytic carbon coating experiments with an entrained bed were successfully performed. Author (NSA)

N68-28050# Oak Ridge National Lab., Tenn.

APPLICATION OF GAMMA RAY DETECTION FOR REACTOR DIAGNOSIS

D. P. Roux, D. N. Fry, and J. C. Robinson 20 Mar. 1968 17 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2144) CFSTI: HC$3.00/MF$0.65

Power spectral density (PSD) measurements of the fluctuating current from a gamma-sensitive and a neutron-sensitive ionization chamber are compared as a reactor diagnostic tool in the HFIR operating at power. An analytical model is presented to demonstrate that, when both observed gamma and neutron PSD are normalized by the square of the prompt mean current of the chambers, they yield the same absolute PSD. The analytical result is verified experimentally with a multisection ionization chamber, composed of electrically independent closely located neutron-sensitive and gamma-sensitive chambers. In the case of the gamma chamber, an estimate of the current component caused by the delayed photons emitted by the radioactive fission products is necessary to measure the absolute PSD. In this experiment the "delayed" current component has been estimated to be 13% of the total gamma current. Author (NSA)

N68-28061# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).

DETERMINATION OF THE RADIATIVE HISTORY OF EXPENDED NUCLEAR FUELS BY MEANS OF GAMMA-SPECTROSCOPIC INTENSITY MEASUREMENTS ON THE FISSION PRODUCTS [BESTIMMUNG DER BESTRAHLUNGSGESCHICHTE ABGEBRANNTER KERNBRENNSTOFFE MITTELS GAMMA-SPEKTROSKOPISCHER INTENSITAETSMESSUNGEN DER SPALTPRODUKTE]

M. J. Higatsberger and H. Bruneder 1968 21 p refs In GERMAN Submitted for publication
(SGAE-G-5/1968) CFSTI: HC$3.00/MF$0.65

A FORTRAN computer program for determining the radiative history is presented which allows for two, four, or any number of parameters. Tables are included showing the isotopic structure for Ru 103, Ru 106, Cs 134, Cs 137, and Nb 95 as a function of the irradiation time in years in dependence of neutron dosage and with the isotope concentration/cm^3 shown as a parameter. Transl. by K.W.

N68-28073# Oak Ridge National Lab., Tenn.

CALIBRATION OF THE SNAP-10A PUMP AS A MAGNETIC FLOWMETER

A. M. Smith 4 Apr. 1968 23 p
(Contract W-7405-ENG-26)
(ORNL-TM-2073) CFSTI: HC$3.00/MF$0.65

A SNAP-10A permanent-magnet pump was installed in an existing flowmeter-calibration test facility and calibrated as a magnetic flowmeter. The pump was calibrated at NaK flow rates of 0.25 to 5.0 gpm and pump inlet temperatures of 200, 400, 600, and 800°F. Calibration curves show that the signal generated in the pump is strongly affected by a temperature difference between the points where the flow signal leads are attached. The lead junctions should be maintained isothermal if the SNAP-10A pump is to provide good flow measurements at low flow rates and temperatures above 200°F. Author (NSA)

N68-28084# Gulf General Atomic, San Diego, Calif.

CORE HEAT TRANSFER MEASUREMENTS DURING RISE TO POWER IN PEACH BOTTOM (RESULTS OF POST CONSTRUCTION R&D PROCEDURES DO-5 AND GO-4)

R. K. Lane and J. F. Peterson 1 Feb. 1968 26 p ref
(Contract AT(04-3)-314)
(GAMD-7911) CFSTI: HC$3.00/MF$0.65

Results are presented of two tests performed during the rise-to-power program to measure the heat transfer film coefficient as a function of helium flow through the Peach Bottom reactor core. Test DO-5 was performed for flow variations up to 35% nominal full flow, and GO-4 was conducted to determine the heat transfer film coefficient variation over the range of 40 to 100% of nominal full helium flow. NSA

N68-28085# Gulf General Atomic, San Diego, Calif.

XENON POISONING DURING RISE TO POWER IN PEACH BOTTOM (RESULTS OF POST CONSTRUCTION R&D TEST PROCEDURES DP-8, GP-1, AND GP-3)

J. R. Brown and K. R. van Howe 22 Jan. 1968 21 p refs
(Contract AT(04-3)-314)
(GAMD-7910) CFSTI: HC$3.00/MF$0.65

In performing a Xe buildup or Xe decay test, the reactor power level is rapidly (<3 hours) changed from a near equilibrium ^{135}Xe and temperature condition to a new set of conditions. These new reactor conditions are held constant for 48 to 72 hours. As the Xe decays or builds up, the control rod positions required to maintain criticality are recorded. From the control rod calibration curves, the reactivity changes with time are determined. The calculation of the changes in the reactivity effect of ^{135}Xe on the core reactivity is made using the computer code GARP. Results are presented. Author (NSA)

N68-28086# Southern Nuclear Engineering, Inc., Dunedin, Fla.

INVESTIGATION OF THE USE OF AQUEOUS SOLUTIONS AS EMERGENCY COOLANTS Quarterly Report

C. Rogers McCullough, Gilbert M. Brown, and R. P. Hancock 1 Apr. 1968 18 p refs
(Contract AT(40-1)-3749)
(SNE-38; QR-1) CFSTI: HC$3.00/MF$0.65

The benefits of using additives in water as the emergency coolant for reactor cores are determined. The test results of spray-cooled Zircaloy cladding are presented. Durability tests for the heater cladding of stainless steel and thermocouple error determination are described. NSA

N68-28089# Phillips Petroleum Co., Idaho Falls, Idaho.

EXPERIMENTAL EVALUATION OR EMERGENCY CORE SPRAY COOLING PERFORMANCE

R. T. Jensen Mar. 1968 39 p refs
(Contract AT(10-1)-205)
(IDO-17249) CFSTI: HC$3.00/MF$0.65

A study was performed to determine the heat transfer mechanisms associated with the use of core spray systems. A nine-rod array of electrically heated rods was enclosed in a glass cylinder. The rods were allowed to heat until the surfaces reached predetermined temperatures between 500 and 1500°F. The rods were then sprayed with cold water and the resulting phenomena observed. Because the rod surfaces were at temperatures above the Leidenfrost point, the water was ejected from the surface and thrown out to the inside wall of the cylinder. A water film eventually formed near the top of the rods with "sputtering" occurring at the leading edge of the film; the lower portion of the rods remained dry until the film progressed down the full length of the rods. The heat transfer mechanism was found to be radiation from rod to rod, radiation to the water film on the cylinder wall, and natural convection to the steam in the cylinder when the rod surface temperatures were above 1250°F. At rod surface temperatures below 1250°F, an additional heat transfer mechanism, which cannot be readily defined at this time, accounts for as much as 65 percent of the total heat transfer. Author (NSA)

N68-28109# Iowa State Univ. of Science and Technology, Ames.

NEUTRON KINETICS OF HEAVY WATER MODERATED REACTORS

Joseph Samuel Crudele Feb. 1968 82 p refs
(Contract W-7405-ENG-82)
(IS-1808) CFSTI: HC$3.00/MF$0.65

The integral solution form of the reactor kinetic equations developed by Keepin and Cox was used to obtain neutron responses to ramp and step changes of reactivity in U-235 fueled, D_2O moderated reactors. The errors introduced by the size of the time interval used in the Simpson rule approximation to this solution were studied. Comparisons were made for the effects of using fast fission delayed neutrons and thermal fission delayed neutrons. Results were also obtained for the effects caused by changes in the number of delayed neutron groups used, the gamma ray transmission, the total effective delayed neutron fraction and the prompt neutron lifetime. The characteristic parameters Sj, Aj and Bj were generated for neutron lifetimes from 10^{-4} to 10^{-3} seconds using 14 delayed neutron groups, a gamma ray transmission of 70 percent and a total effective delayed neutron fraction of 0.0075. Author (NSA)

N68-28110# Hahn-Meitner-Institut fur Kernforschung, Berlin (West Germany).

CHEMICAL ASPECTS OF REACTOR SAFETY (LITERATURE REVIEW [CHEMISCHE ASPEKTE DER REAKTORSICHERHEIT (LITERATURUEBERSICHT)] Semiannual Report
E. Hoinkis Mar. 1968 54 p refs In GERMAN; ENGLISH summary Supported in part by the Min. for Sci. Res.
(HMI-B-68; SAR-2)

The chemical aspects of reactor safety are described generally. These include: the release and transport of fission products from uranium dioxide (UO_2) and coated particle fuels; adsorption, release, and transport of fission product iodine and iodine compounds; containment filtration systems; metal–water reactions; oxidation of graphite and coated particles by steam; corrosion; reaction of fuel materials with water and steam; and chemical problems in the use of sodium coolants. NSA

N68-28120# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.

VAPORIZATION OF ACTINIDES AND THEIR BINARY COMPOUNDS. 4: VAPORIZATION OF BINARY NEPTUNIUM AND PLUTONIUM COMPOUNDS [VYPAROVANI AKTINIDU A JEJICH SLOUCENIN. 4: VYPAROVANI NEKTERYCH SLOUCENIN NEPTUNA A PLUTONIA]
I. Krivy Jun. 1967 19 p refs In CZECHOSLOVAKIAN; ENGLISH summary
(UJV-1832-4)

Studies were made on the vaporization of some binary compounds of neptunium and plutonium. It involves the survey and the critical treatment of available papers in the field up to 1st June 1966, with special attention given to the compounds of interest in nuclear reactor technology, namely PuO_2 and PuC_2. For each two-component system discussed there is a separate chapter presenting these fundamental data: the list of the binary compounds with their crystal structures, the composition of the vapor over the condensed phases (at least qualitatively) together with the dependence on the experimental conditions, and last, the results of tensimetric experiments usually given in the form log P = f(T). The values of dissociation energy for the gaseous species or eventually those of standard free energy of formation for the individual condensed phase (ΔG_f^0) are presented provided that they are derived on the basis of tensimetric data. Author (NSA)

N68-28124# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

RIBOT: A PHYSICAL MODEL FOR LIGHT-WATER LATTICES CALCULATIONS
Paolo Loizzo Feb. 1968 43 p refs
(Contract AT(45-1)-1830)
(BNWL-735) CFSTI: HC$3.00/MF$0.65

The computer program, RIBOT-5, is a zero dimensional reactor physics code used for calculating criticality and burnup of light-water reactors. The code requires as input, essential extensive reactor parameters (fuel rod radius, water density, etc.). The nuclear constants (intensive parameters) are calculated with a five-group model (2 thermal and 3 fast groups). A fitting procedure, imitated from the classical engineering approach to problem solving is systematically employed to reduce the computation time of the code. Zero dimension burn-up calculations are made in an automatic way. A summary physical description, a check with the latest set of experiments with PuO_2–UO_2 rods, and a description of the input–output procedures are presented. Author (NSA)

N68-28126# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

FAST FLUX TEST FACILITY: EVALUATION OF CONCEPTUAL FEATURES FOR THE REACTOR REFUELING SYSTEM
C. R. Nash and C. L. Peckinpaugh Mar. 1968 37 p refs
(Contract AT(45-1)-1830)
(BNWL-683) CFSTI: HC$3.00/MF$0.65

The evaluation effort for selecting a reactor refueling concept for the FFTF is described. Different methods of fuel handling are investigated with reference to safety, economics, flexibility and versatility, interfacing system compatibility, and experiment handling requirements. NSA

N68-28128# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

FTR FUEL DESIGN AND ANALYSIS: HYDRAULIC, SODIUM, AND MECHANICAL TESTING
P. D. Cohn Mar. 1968 53 p refs
(Contract AT(45-1)-1830)
(BNWL-599) CFSTI: HC$3.00/MF$0.65

The plan for water flow, sodium flow, and mechanical testing of FTR driver fuel pins, bundles, and subassemblies is presented. Mechanical effects of vibration, fretting corrosion, and fretting fatigue couples with the vibration and material removal measurements noted in hydraulic and the Na dynamic tests are analyzed. The thermal-hydraulic development studies examine aberrated pin bundles, variable spacing, variable spacer geometry, and differences between compliant grid spacers and the reference wire wrap spacers. Vessel hydraulic mockup studies for the flow distribution analysis are described. Author (NSA)

N68-28129# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

PROGRAM FOR CALCULATING THE STEADY-STATE DEFORMATION RATES FOR CYLINDRICAL FUEL ELEMENTS
K. R. Mercky Jan. 1968 30 p refs
(Contract AT(45-1)-1830)
(BNWL-663) CFSTI: HC$3.00/MF$0.65

The assumptions, mathematical formulation, and the computer program calculating the steady-state behavior of cylindrical fuel pins are presented. A listing of the SWELL program used for swelling and mechanical behavior of the fuel and cladding material is included. NSA

N68-28130# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.

SPACE-TIME REACTOR KINETICS DEVELOPMENT AT KAPL
Weston M. Stacey, Jr. Mar. 1968 42 p refs Presented at the Brookhaven Conf. on Ind. Needs and Academic Res. in Reactor Kinetics, Upton, N. Y., 8–9 Apr. 1968
(Contract W-31-109-ENG-52)
(KAPL-P-3425; CONF-680414-1) CFSTI: HC$3.00/MF$0.65

Efforts in the development of methods for the calculation of transient power distributions in operating reactor cores during a variety of plausible transients are reviewed. The development of Xenon spatial transient analysis and space-time flux synthesis is examined. Studies on defining nodal coupling coefficients and on the influence of spatial effects on the kinetics of low source reactor startups are also discussed. NSA

N68-28132# Atomic Power Development Associates, Inc., Detroit, Mich.

SODIUM SAMPLING IN THE ENRICO FERMI ATOMIC POWER PLANT

E. F. Madsen Mar. 1968 99 p refs
(Contract AT(11-1)-865)
(APDA-306) CFSTI: HC$3.00/MF$0.65

The sampler designs used over the years in the primary sodium system of the Enrico Fermi Atomic Power Plant are described in detail. These include the earlier thief type as well as the present permanent flowthrough station. The cleaning procedures, sampling procedures, and analytical results are presented as the basis for evaluating the adequacy of the designs. Author (NSA)

N68-28146# Los Alamos Scientific Lab., N. Mex.

COMPARISON OF POWER PROFILE CALCULATIONS WITH EXPERIMENT IN UHTREX

J. L. Meem and J. C. Vigil [1967] 6 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-ENG-36)
(LA-DC-9427; CONF-680601-11) CFSTI: HC$3.00/MF$0.65

One- and two-dimensional S_n transport calculations of the power profile or flux distribution in the Ultra High Temperature Reactor Experiment are compared with measurements made both in the cold-critical experiment, UCX-1, and in the fully assembled reactor, UCX-2. Author (NSA)

N68-28147# Los Alamos Scientific Lab., N. Mex.

CALCULATED AND EXPERIMENTAL FLUX AND POWER DISTRIBUTIONS IN UHTREX

J. C. Vigil, R. J. La Bauve, and J. L. Meem [1967] 4 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-ENG-36)
(LA-DC-9511; CONF-680601-14) CFSTI: HC$3.00/MF$0.65

One- and two-dimensional S_n transport calculations of neutron flux and power distributions in the Ultra High Temperature Reactor Experiment are compared with experimental results. Author (NSA)

N68-28161# Idaho Nuclear Corp., Idaho Falls.

BURNUP DETERMINATION OF NUCLEAR FUELS Quarterly Project Report, Apr. 1–Jun. 30, 1967

Frederick L. Lisman, ed., William J. Maeck, ed, and James E. Rein, ed. Apr. 1968 16 p refs
(Contract AT(10-1)-1230)
(IN-1178) CFSTI: HC$3.00/MF$0.65

In a continuing program to develop methods for the accurate determination of the burnup of nuclear fuels, the main emphasis was additional measurements of the absolute, thermal fission yields of stable and long-lived isotopes of krypton, xenon, rubidium, and ruthenium for ^{235}U. Also measured was α, the thermal capture-to-fission ratio, for ^{235}U. The determined values are presented. Author (NSA)

N68-28162# Nuclear Utility Services, Inc., Washington, D. C.

RADIOLOGICAL SAFETY STUDIES OF SPACE NUCLEAR SYSTEMS

James R. Coleman and Lawrence J. Perez, Jr. Oct. 1967 270 p refs Prepared for Sandia Corp.
(Contract AT(29-1)-789)
(SC-CR-67-2729; QR-4; FR-4) CFSTI: HC$3.00/MF$0.65

A mathematical description of the significant pathways by which man might become adversely affected from an unwanted release of SNAP fuel is presented. Developments and applications for determining radiation doses with interaction probabilities are presented for both intact and dispersed re-entry modes of isotopic SNAP units using ^{210}Po, ^{147}Pm, ^{238}Pu, ^{90}Sr, or ^{171}Tm. The models presented reflect varying degrees of thoroughness with more effort exhibited on those areas considered to be the most important at this time. For example, the probabilistics associated with the lung organ dose model were thoroughly studied and presented in great detail. This was done because the fuel forms currently under consideration pose a significant hazard to the pulmonary compartment, that appears to be critical in the evaluation of the hazards. The models included herein are: internal organ dose for inhalation and ingestion, skin dose from direct deposition on the skin surface, whole body dose from a field of deposited material, resuspension of ground deposited particles, contamination of vegetation and meats, surface water transport, and overall mission interaction probability model for intact re-entry. Author (NSA)

N68-28167# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.

LATTICE EXPERIMENTS WITH SIMULATED BURNED-UP FUEL FOR HEAVY WATER POWER REACTORS

N. P. Baumann, J. L. Crandall, R. L. Olson, G. F. O'Neill, D. J. Pellarin et al Feb. 1968 75 p refs
(Contract AT(07-2)-1)
(DP-1122) CFSTI: HC$3.00/MF$0.65

The changes in lattice physics parameters accompanying fuel burnup in natural-uranium-fueled D_2O power reactors were studied by measuring bucklings and neutron reaction rates for D_2O-moderated lattices of UO_2 rod clusters containing five different concentrations of ^{235}U and the plutonium isotopes. Both 19- and 31-rod clusters with D_2O, gas, and organic coolants were used at triangular lattice pitches of 9.33 and 12.12 inches. Substitution measurements in natural UO_2 lattices in the Process Development Pile determined the uniform lattice bucklings. Exponential measurements in the Subcritical Experiment determined the changes in buckling induced by uniform lattice heating. Foil activations, also performed in the Subcritical Experiment, measured the thermal neutron distributions in terms of Mn activations, the thermal neutron spectral indices in terms of Lu–Mn and ^{239}Pu–^{235}U activations, resonance neutron capture in ^{238}U in terms of the cadmium ratio for ^{239}Np production, fast fissions in ^{238}U and all fissions in ^{235}U in terms of the induced fission product activities, and fissile material conversion ratios in terms of the ^{238}U capture to ^{235}U fission ratios. These results were compared with calculations by the HAMMER code, a one-dimensional, integral-transport cell calculation performed in 84 energy groups. Although agreement between experiment and theory was in general good, significant discrepancies were observed in the spectral index and resonance capture calculations. These discrepancies were tentatively assigned primarily to difficulties in reducing the highly heterogeneous fuel clusters into a ring model for the one-dimensional calculations. Author (NSA)

N68-28168# Atomic Power Development Associates, Inc., Detroit, Mich.

CROSS SECTION FOR EVALUATION AND CRITICAL EXPERIMENT ANALYSIS FOR FAST REACTORS

T. A. Pitterle and M. Yamamoto (Central Res. Inst. for Elec. Power Ind., Japan) Jun. 1967 101 p refs Prepared for Edison Elec. Inst.
(APDA-201)

A neutron cross section evaluation and critical experiment analysis conducted in support of PuO_2 core studies for the Enrico

Fermi Reactor are presented. Cross sections of primary importance for fast reactor analysis were evaluated for use with the Argonne National Laboratory (ANL) MC2 code which generates multigroup data from basic cross section data. The resulting multigroup cross sections were used for diffusion theory calculations of ZPR-III Assemblies 47 and 48. A comparison of calculation with experiment is presented for these critical experiments. Author (NSA)

N68-28172# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.

ANALYSES OF THE FISSION GASES RELEASED WITHIN SPENT YANKEE FUEL RODS

W. A. Bezella Feb. 1968 90 p refs
(Contract AT(30-1)-3017)
(WCAP-6087) CFSTI: HC$3.00/MF$0.65

An analysis was conducted to the gases found within 32 UO_2 fuel rods removed from the Yankee reactor. These rods selected for gas analysis experienced average fuel burnups from 3000 MWD/MTU up to 36,000 MWD/MTU. Irradiation was at rather low fuel heat ratings which ranged from 0.94 kw/ft to 4.1 kw/ft with fuel average pellet temperatures during irradiation estimated to range from 785°F to 1450°F. The composition of the total gas collected from the fuel rods was determined spectrographically with the amount of the gas constituents evaluated volumetrically. The evolved fission gases (Kr and Xe) found within the fuel rods varied between 0.05 percent and 8.5 percent of the amount which was theoretically produced. Helium gas found within the fuel rods ranged from 1.5 percent to approximately 100 percent of that generated and was attributed to ternary fissions. An attempt to correlate the helium and the fission gas (Kr and Xe) release data from 20 to these fuel rods using a modified diffusion model met with limited success. The rather low temperature experienced by the UO_2 fuel, the relatively large amounts of H_2 and He gas present within the fuel rods, the uncertainties associated with the prediction of fuel rod thermal histories, and the basic diffusion model itself precluded the establishment of a unique set of correlating diffusion parameters. Author (NSA)

N68-28196# Los Alamos Scientific Lab., N. Mex.

LARCA: A FORTRAN-4 CDC-6600 PROGRAM FOR CALCULATING FLUX-WEIGHTED CROSS SECTIONS

R. C. Anderson 29 Mar. 1968 15 p ref
(Contract W-7405-ENG-36)
(LA-3873-MS) CFSTI: HC$3.00/MF$0.65

A FORTRAN-IV, CDC-6600 program, LARCA, which computes flux-weighted cross sections for homogeneous or heterogeneous mixtures of materials, is described. The program also computes infinite medium fluxes, reaction rates, and other related quantities. The flux-weighted cross sections are punched in a form suitable for use in the multigroup transport theory program DTF-IV. Author (NSA)

N68-28203# Atomic Power Development Associates, Inc., Detroit, Mich.

SCRAM TESTS TO DETERMINE SHUTDOWN TRANSIENT CHARACTERISTICS OF THE ENRICO FERMI REACTOR AND ASSOCIATED HEAT TRANSPORT SYSTEM

M. A. Ziniuk and H. A. Wilber Apr. 1968 45 p refs
(APDA-NTS-15) CFSTI: HC$3.00/MF$0.65

Scram tests were performed at nominal reactor power levels of 9.5, 13.3, 20, and 67 thermal megawatts. During the 9.5-, 13.3-, and 67-Mwt tests, operation was on two coolant loops; whereas, during the 20 Mwt test, operation was on three coolant loops. At 67 Mwt, significant thermal transients of the nature of random fluctuations were observed in the reactor outlet temperature as measured by the temperature detectors. Thermal fluctuations and transients occurring in scrams at 9.5, 13.3, and 20 Mwt were insignificant, apparently because of the low power levels involved. Although the temperature rates of change experienced were comparatively high, the total change in temperature in each instance was well below the specification value. Transport lags of the principal plant parameters were read from the scram test data obtained on strip chart recorders. Performance of all interlock and reset circuitry, as well as operation of the reactor control system, was found to be satisfactory. Author (NSA)

N68-28205# Dynatech Corp., Cambridge, Mass.

INVESTIGATION OF BOILING FLOW REGIMES AND CRITICAL HEAT FLUX Quarterly Progress Report, Mar. 16–Sep. 15, 1967

A. E. Bergles, J. P. Roos, S. C. Abraham, S. C. Gouda, and J. S. Maulbetsch Jan. 1968 67 p refs
(Contract AT(30-1)-3304)
(NYO-3304-11) CFSTI: HC$3.00/MF$0.65

Film thickness and critical heat flux data for 0.4 in. tubes were taken. The critical condition for $G \cong 0.2 \times 10^6$ and 0.4×10^6 lbm/hr-ft^2 occurs at approximately constant quality for a wide range of inlet conditions. Film persistence and abnormally high critical heat fluxes are observed at inlet qualities greater than about 50 percent. More detailed observations of acoustic instabilities are presented. In the subcooled region the inlet pressure fluctuations can be a significant percentage of the pressure level, and pressure drop oscillations are far in excess of the steady-state pressure drop. Using the results of previous analysis, calculations are made for frequency and threshold oscillations. Design details of the electrically heated four-rod bundle test section are presented. Visual studies were carried out in an air–water loop to determine the most satisfactory geometrical configuration for the introduction of the steam–water mixture at the inlet of the bundle assembly. Author (NSA)

N68-28213# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

ULTRASONIC BOND TESTING BETWEEN TUBES AND METALLIC URANIUM CORE IN NUCLEAR FUEL ELEMENTS, PART 1

Z. Powlowski and M. Wiaderny 1967 41 p In POLISH; ENGLISH summary
(INR-856/XIV/PS)

The ultrasonic immersion testing of nuclear fuel elements is described. It is shown that the ultrasonic method of testing makes it possible to detect not only the unbonding between tube and metallic uranium core, but traces on the oscilloscope screen give information on the internal defects, the density and porosity of metallic uranium core. The conclusion on these two latter inhomogeneities could be drawn from ultrasonic velocity and attenuation measurements. The principles for the interpretation of oscilloscope traces as well as characteristic oscilloscope traces connected with different defects are given. Author (NSA)

N68-28216# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

FISSION GASES, RADIOIODINES AND ACTIVATION PRODUCTS IN THE NPD PRIMARY COOLANT DURING THE FIRST FIVE YEARS OF OPERATION

G. M. Allison Mar. 1968 21 p refs
(AECL-3085) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

The major γ-emitting activation products ($t_{1/2} > 1$ h) found in the NPD primary coolant under steady operating conditions are Ar-41, Na-24 and F-18. When the system is disturbed by trips and startups activated corrosion products become major constituents in the γ-ray spectra of the D_2O. Results for the fission gases Kr-88, Xe-135 and Xe-133 and the radioiodines I-135, I-133 and I-131 have indicated that defected UO_2 fuel elements have been present in the reactor during most of its operating time. Highest release rates were measured during the period when a deliberately defected fuel bundle was irradiated at $\int \lambda_\theta d\theta \approx 45$ W/cm. At least three defected 19-element bundles which were discharged from the reactor up to March 1967 had undergone mechanical damage. These bundles could not have exceeded a maximum $\int \lambda_\theta d\theta$ of $\approx$ 20 W/cm. Measured release rates have been compared with those calculated using a release model developed from tests of defected fuel in a loop in the NRX reactor. Author

N68-28223# Los Alamos Scientific Lab., N. Mex.

SMALL OUT-OF-PILE THERMIONIC CONVERTER

Thurman G. Frank and Richard C. Anderson 16 Apr. 1968 8 p refs
(Contract W-7405-ENG-36)
(LA-3813) CFSTI: HC$3.00/MF$0.65

The preliminary design of a nominal 10-kW electrical space power supply is presented. The design uses heat pipes together with radiation coupling to transfer heat from a small compact reactor to a converter consisting of a large number of thermionic diodes of planar design. Heat pipes are used to concentrate and to disperse heat flux within individual diodes. Each component of the power supply is conservatively designed, and considerable improvement could be realized from additional study and a modest development program. The unshielded specific weight of the power supply is $\approx$95 lb/kW electrical. Author (NSA)

N68-28231# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.

POST-IRRADIATION EXAMINATION OF CVTR FUEL ASSEMBLIES Quarterly Progress Report, Period Ending Dec. 31, 1967

M. G. Balfour, ed. Mar. 1968 64 p
(Contract AT(30-1)-3850)
(WCAP-3850-2) CFSTI: HC$3.00/MF$0.65

The results presented were derived from data from nondestructive examinations, destructive examinations, and metallurgical evaluation and fuel failure analysis. Waste disposal and material accountability are discussed. NSA

N68-28243# Technische Hogeschool, Eindhoven (Netherlands).

RESEARCH PROGRAM ON THE HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS OF A PRESSURIZED WATER REACTOR Final Report

Dec. 1967 59 p refs
(Contract EURATOM-011-69-1-TEEN (RD))
(WW-015-R-128; EURAEC-1997; EUR-3790)

A description of the 140 atmospheres pressurized water loop is presented. A review of the activities of the instrument development undertaken is also presented. A description of a mathematical model to analyze the flow process in the multirod fuel assembly incorporating the transverse transport of fluid coming from diffusion and radial pressure differences is included. Author (NSA)

N68-28285# Los Alamos Scientific Lab., N. Mex.

CRITICAL EXPERIMENTS IN UHTREX

B. M. Carmichael [1967] 3 p ref Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-ENG-36)
(LA-DC-9424; CONF-680601-3) CFSTI: HC$3.00/MF$0.65

A description of the UHTREX facility is presented. Physics measurements for critical operation are presented. NSA

N68-28286# Los Alamos Scientific Lab., N. Mex.

USE OF SLOW TRANSIENT EXPERIMENTS TO EVALUATE FUEL TEMPERATURE COEFFICIENTS IN REACTORS

J. C. Vigil [1967] 4 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-ENG-36)
(LA-DC-9425; CONF-680601-15) CFSTI: HC$3.00/MF$0.65

Numerical calculations of the fuel temperature coefficient in UHTREX are presented. The series of slow transients for verifying the calculated results are performed using the ANCON code. NSA

N68-28287# Los Alamos Scientific Lab., N. Mex.

LIQUID JET SUPER FLUX REACTOR (LJSFR)

L. D. P. King [1967] 3 p refs
(Contract W-7405-ENG-36)
(LA-DC-9413) CFSTI: HC$3.00/MF$0.65

The description of a Liquid Jet Super Flux Reactor (LJSFR) is presented. The LJSFR is designed similar to the operation of a flame or jet engine except that neutrons replace the normal flame propagation front and no oxidizer is required to burn the uranium supplied by the liquid fuel. Advantages of the system are listed. NSA

N68-28295# Idaho Nuclear Corp., Idaho Falls.

BURNUP DETERMINATION OF NUCLEAR FUELS Quarterly Project Report, Jan. 1–Mar. 31, 1967

Frederick L. Lisman, ed., William J. Maeck, ed., and James E. Rein, ed. Jan. 1968 53 p refs
(Contract AT(10-1)-1230)
(IN-1157, Rev.) CFSTI: HC$3.00/MF$0.65

Absolute uranium 233 and uranium 235 thermal fission yields for the stable and long-lived fission products of rubidium, strontium, and barium were determined by isotope dilution mass spectrometry. Values are given for each of four dissolved U-233 capsules and three U-235 capsules. Procedures are included for the separation, mass spectrometric, analysis, calculation, and error propagation for the determination of fission products of Ba, Ru, and Sr; and computer program schematics for buildup and burnout of each of the fission products are included. M.W.R.

N68-28298# Los Alamos Scientific Lab., N. Mex.

GEOMETRIC PROBLEMS AND CALCULATIONAL METHODS ASSOCIATED WITH A RADIALLY LOADED REACTOR

R. J. LaBauve and J. C. Vigil [1967] 4 p refs Presented at the 14th Ann. Meeting of the Am. Nucl. Soc., Toronto
(Contract W-7405-ENG-36)
(LA-DC-9426; CONF-680601-6) CFSTI: HC$3.00/MF$0.65

The calculation of the thermalization and heterogeneity effects in the UHTREX reactor core is described. Cell calculations were run in one- and two-dimensional representative geometries for each radial position, each cell consisting of the fuel element with an average volume of surrounding moderator. The thermal spectral range was considered to extend from zero to 3 eV. The thermal flux profile for a fuel element is presented. NSA

N68-28299# Idaho Nuclear Corp., Idaho Falls.

REACTOR FUELS AND MATERIALS DEVELOPMENT Annual Report, for FY 1967

G. W. Gibson, ed., and M. J. Graber, ed. Feb. 1968 157 p refs
(Contract AT(10-1)-1230)
(IN-1111) CFSTI: HC$3.00/MF$0.65

Progress is reported on developments on the uranium-aluminum intermetallic fuel systems. Developments include the routine use of material as dispersions in high flux test reactor fuel elements as well as irradiation testing of bulk material in capsules. An analysis is presented which summarizes the use of uranium aluminides culminating in the successful performance of 700 commercial fuel elements. Fabrication procedures and alloy development reported include the use of Fe–Cr–Al–Y alloys for cladding, and an investigation of the possible advantages of Si additions to aluminum alloy fuel elements. The results are reported on an examination of the fracture surface produced in a controlled fracture mechanics program conducted on the PM-2A pressure vessel after this vessel had received a fluence of about 10^{19} neutrons/cm^2. Other detailed irradiation effects were studied by the electron probe on UO_2 diffusion zones. Corrosion studies demonstrate the resistance of 316 stainless steel to chlorides and NaK. Author

N68-28304*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AXIAL POWER TAILORING TO OBTAIN CONSTANT FUEL-CENTERLINE TEMPERATURE IN A NUCLEAR REACTOR
Harry W. Davison Washington Jul. 1968 43 p refs
(NASA-TN-D-4658) CFSTI: HC$3.00/MF$0.65 CSCL 18L

The total-power output from a nuclear reactor can be increased by tailoring the axial-power shape if reactor power is limited by fuel-centerline temperature. The potential power gains and the axial-power shape required to obtain a constant fuel-centerline temperature are calculated using steady-state heat-transfer calculations on a long fuel rod cooled externally by forced convection. Steady-state two-group neutron diffusion theory is used to predict the axial-fuel loading required to obtain the desired axial-power shape. Fuel loadings and neutron-flux distributions are presented for various axial-power shapes required in a reflected, water moderated, and cooled reactor. Author

N68-28320# Atomic Energy Establishment, Winfrith (England).
DRYOUT DURING FLOW AND POWER TRANSIENTS
D. Moxon and P. A. Edwards Oct. 1967 47 p refs
(AEEW-R-553) CFSTI: HC$3.00/MF$0.65

Reported are results of six series of transient tests that were designed to determine the validity of current methods used to predict the onset of dryout during flow and power transients in the S.G.H.W. prototype reactor. The experiments were carried out with forced convection water at 100 psia. Four different test sections were used: uniformly heated tubes of 6 ft. and 12 ft., a uniformly heated 37-rod cluster of 12 ft. heated length and a nonuniformly heated tube of 12 ft. heated length. Comparisons are made between the experimental and theoretical predictions of the time taken to reach dryout after the initiation of the transients. The theoretical predictions are based on the assumption that dryout occurs in a transient at the same combination of local mass velocity (G), steam quality (X), and heat flux (Q) as it does for the steady state. Results indicated that for all tests in which the experimental and theoretical predictions differed significantly, the predicted time of dryout was earlier than the experimental time; however, for the nonuniformly heated tube the discrepancy between these times was very small, being about 0.1 sec. In view of these and the lack of information on nonuniformly heated clusters, it is concluded that reactor assessment calculations should continue to be based on the proposed theoretical prediction method. Author

N68-28321# Argonne National Lab., Idaho Falls, Idaho.
REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT
26 Mar. 1968 151 p refs
(Contract W-31-109-ENG-38)
(ANL-7427) CFSTI: HC$3.00/MF$0.65

Progress in both specific reactor projects and general engineering research and development programs is reported. Cited are studies of: reactor fuel elements; Inconel 625; reactor fuels; critical assemblies; sodium; tungsten carbides; Experimental Breeder Reactor II; uranium carbides; uranium isotopes (U^{235} and U^{238}); fissium; silicon; selenium; yttrium; uranium sulfides; nickel lithium; plutonium oxides; thermal stresses; core structural dynamics in reactors; plutonium; plates; heat transfer; fluid flow; and reactor containment structures; S.C.W.

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N68-26985# Weizmann Inst. of Science, Rehovoth (Israel).
RESOLUTION AND NOISE IN FOURIER SPECTROSCOPY
Nathan Jacobi Aug. 1967 18 p refs
(Contract AF 61(052)-838)
(AFCRL-68-0115; SR-10; AD-668525)

The dependence of resolution on both noise and instrumental factors is stressed. The statistical decision theory approach of Harris is used in the spectroscopic problem treated by Kozlov, and the probability of correct decision between two possible spectra is expressed as a function of the ratio of the quadratic content of the difference between the spectra to the noise. The results are applied to fourier spectroscopy, where in addition to instrumental factors considered by Kozlov finite line widths are taken into account. Author (TAB)

N68-26992 Brown Univ., Providence, R. I.
THE SPLINE IN TENSION (HYPERBOLIC SPLINE) AND THE REDUCTION OF EXTRANEOUS INFLECTION POINTS
Daniel George Schweikert (Ph.D. Thesis) 1966 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-2285

The cubic spline function, a mathematical version of the draftsman's spline, will occasionally produce oscillations and inflection points which are undesirable when the interpolated points are intended to indicate the geometric outline of a physical body, such as a ship hull or an automobile body. A definition of an "extraneous" inflection point is presented following a discussion of the mathematically vague concept of a "faired" curve. It is suggested that an absence of extraneous inflection points is a necessary condition for a "faired" curve and simplified rules to determine if a function meets that condition are presented. The function associated with a spline in tension is presented and shown to be free of extraneous inflection points for a sufficiently large value of tension. Dissert. Abstr.

N68-27014# Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.
A STUDY OF NON-LINEAR DIRICHLET PROBLEMS
Dale W. Lick (Brookhaven Natl. Lab.) and J. Nelson Tunstall 27 Feb. 1968 36 p refs
(Contract W-7405-ENG-26)
(K-1737)

The Dirichlet problem $\Delta u = f(u)$, $u \geq 0$, in R, $u = \phi$, on R', is considered where f is non-linear, R is a bounded domain with boundary R', ϕ is a nonnegative continuous function, and Δ is the Laplacian operator. The finite difference analogue is analyzed. Iteration methods and numerical calculations are included for the approximate solution with $f(u) = c_1u/1 + c_2u)$, where c_1 and c_2 are positive constants. Also, the finite difference analogue of the Dirichlet problem $\Delta u = f(u,v)$, $u, v \geq 0$, in R, $\Delta v = g(u,v)$, $u, v \geq 0$, in R, $u = \phi$, $v = \psi$, on R', is analyzed where ϕ and ψ are nonnegative continuous functions and $f(u,v) = c_1u/(1 + c_2v + c_3u)$ and $g(u,v) = -(c_4u)/(1 + c_2v + c_3u)$, c_1, c_2, c_3, and c_4 being positive constants. Iteration methods and numerical calculations are included for the solution of this problem. Author (NSA)

N68-27030# Aerospace Corp., El Segundo, Calif. Lab. Operations.
MOIRE INTERFEROMETRY WITH EMBEDDED GRIDS, EFFECT OF OPTICAL REFRACTION
R. L. Kerber and J. S. Whittier Apr. 1968 39 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-30)-6; SAMSO-TR-68-174; AD-669065)

Optical refraction resulting from refractive index gradients present in nonhomogeneously stressed models is investigated as a limitation on the usefulness of moire interferometry employing embedded grids. Estimates of apparent displacements caused by internal refraction are derived for representative static and dynamic problems: Boussinesqs problem, and the problem of a spherically expanding pulse, respectively. Refraction effects are found to be far larger in the dynamic case. Apparatus for dynamic moire interferometry employing single-spark, high-speed photography is briefly described, and observations of transient motions in Plexiglas models loaded nondestructively by pellet impact are discussed. The moire results are compared with motion histories obtained using a capacitive transducer. The moire data exhibit significant anomalies whose basic features agree fairly well with the predicted refraction effects for the aforementioned case of a spherically expanding pulse. Author (TAB)

N68-27038 Michigan State Univ., East Lansing.

DYNAMICAL EFFECTS OF ISOTROPIC RADIATION

David Francis Savickas (Ph.D. Thesis) 1966 67 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-7601

A small spherical body traveling through an isotropic radiation field will generally experience a force caused by the momentum it absorbs from the radiation. Due to the Doppler shift, the radiation striking the front of the particle will be of higher frequency than the radiation striking the back of the particle. Also, because of diffraction effects, a small particle will absorb amounts of momentum that differ with the radiation's wavelength. These two factors generally combine to exert a force on the particle and change its velocity. The effect of this force on the particle' motion was investigated. By the use of relativistic mechanics a general expression for the force on the particle due to a plane-parallel beam of radiation was obtained. For approximations at low velocities it was found that the ratio of the initial velocity to the velocity at a later time is independent of the initial velocity. Generally the radiation exerts a retarding force on the motion of the particle. Dissert. Abstr.

N68-27083# Mitre Corp., Bedford, Mass.

MATRIX FORMULATION OF BISTATIC ELECTROMAGNETIC SCATTERING

Peter C. Waterman May 1968 26 p refs
(Contract AF 19(628)-5165; ARPA Order 596; Proj. Defender)
(MTR-543; ESD-TR-67-629; AD-669093)

The purpose of the discussion is to relate the previously developed matrix analysis of electromagnetic scattering explicitly to the experimentally measurable bistatic polarization matrix. In addition, in order to perform the numerical computations more conveniently, a new matrix analysis is described, in which the constraints of reciprocity and energy conservation are employed in the course of obtaining a solution. Author (TAB)

N68-27114 Yale Univ., New Haven, Conn.

ANALYSIS OF ELECTROMAGNETIC TRANSIENTS IN A SINUSOIDALLY STRATIFIED DIELECTRIC MEDIUM

Asher Oscar Pacholder (Ph.D. Thesis) 1967 144 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-8404

The propagation of electromagnetic disturbances in a waveguide whose dielectric constant varies sinusoidally along its length is examined. Analytical expressions for the phase and group velocities are obtained, and a graphical procedure for their determination is introduced. General equations are derived to describe field variations with space and time in a waveguide filled with such a medium. Expressions obtained describe the degradation of arbitrary pulses whose Fourier transforms are frequency limited. In particular, the distortion of a square pulse which has frequency components only in the fourth pass band is investigated. The variation of the field with time at various points within a cell in different cells along the waveguide is analyzed, computed, and interpreted. Dissert. Abstr.

N68-27147 Princeton Univ., N. J.

THE EQUIVALENCE OF ACTIVE AND PASSIVE GRAVITATIONAL MASS

Lloyd Kreuzer (Ph.D. Thesis) 1966 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7384

For point particles three types of mass are operationally defined. The inertial mass of a particle is equal to the applied force divided by the acceleration. The gravitational force exerted on Particle One by Particle Two is proportional to the product of the passive mass of Particle One and the active of Particle Two. These definitions are applied to extended bodies by assuming that the mass of an extended body is the sum of the masses of its parts. The ratio of the active mass to the passive mass of a body is a dimensionless constant that should not depend on the size of the body. The dependence of this ratio on the composition of a body is investigated. It is shown that if the ratio varies from body to body then the laws of conservation of linear momentum, energy and angular momentum do not hold. Past experiments are analysed and it is shown that they restrict this ratio to vary by no more than $1:10^3$ from one substance to another. Dissert Abstr.

N68-27168 Brown Univ., Providence, R. I.

AN ELECTROMAGNETIC DIRECTOR FIELD THEORY

James Baird Walker (Ph.D. Thesis) 1966 120 p
Available from Univ. Microfilms: HC $5.80/MD $3.00 Order No. 67-2298

In an attempt to obtain more detailed information about the electromagnetic field in material media, we associate with each particle in space, including any material media which may be present, a unit cell in the shape of a rectangular parellelepiped. A running Fourier analysis is made of the electromagnetic field, using the unit cell as the region over which the field is analyzed. Assuming the Maxwell's equations hold everywhere, we determine the field equations which the Fourier coefficients, called directors, of the electromagnetic field must satisfy. We then consider the electromagnetic field in finitely deformable media, referring the electromagnetic field to the undeformed state. The electromagnetic field referred to the undeformed state is then analyzed in a manner analogous to that above, when a unit cell is associated with each particle in the undeformed state. Using the transformation properties of these director field quantities with respect to rigid body motions, we derive the equations of motion of a charged, current conducting, non-magnetic, elastic medium in an electromagnetic field in terms of these directors. Constitutive equations relevant to such materials are then discussed. Dissert. Abstr.

N68-27169 Brown Univ., Providence, R. I.

SOUND PROPAGATION IN AN AEROSOL

Samuel Temkin (Ph. D. Thesis) 1966 72 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-2295

Sound attenuation and dispersion by small, dense particles suspended in a gas are studied analytically and experimentally. A theory for attenuation and dispersion based on particulate relaxation processes is given. The close relationship between particulate relaxation and relaxation mechanisms due to lagging molecular or atomic internal degrees of freedom is displayed. The experimental study consists of measurements of attenuation and dispersion in an acoustic interferometer. The interference tube is filled with an aerosol composed of oleic acid particles in nitrogen. Particle size and concentration are measured in situ by spectrophotometric tests. Acoustic dispersion measurements, taken at low values of $\omega \tau_d$ where no previous measurements have been made, indicate good agreement with the theory. Attenuation measurements taken in the range of $\omega\tau_d$ from 0.1 to 4.0 show good agreement with the theory. In particular, they confirm the existence of the predicted maximum. Dissert. Abstr.

N68-27173 California Univ., Berkeley.
THE MAGNETIC MOMENT OF PLUTONIUM 239
John Daly Faust (Ph.D. Thesis) 1966 64 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-8553

The triple loop technique of atomic beam magnetic resonance has been used to determine the magnetic moment of plutonium 239 directly. The final measurement was carried out at a magnetic field of 720 gauss. Hyperfine structure measurements on plutonium 241 and tungsten 185 and tungsten 187 were attempted. These experiments involved the observation of four and six quantum transitions because of the inverted level ordering which was caused by the unusually large values of the quadrupole moments of all of these isotopes. Dissert. Abstr.

N68-27175# Massachusetts Univ., Amherst. Polymer Research Inst.
LIGHT SCATTERING BY LIQUID CRYSTALS
R. S. Stein, M. B. Rhodes, and R. S. Porter Jan. 1968 46 p refs
(Contract Nonr-3357(01))
(ONR-TR-103; AD-669122)

The scattering of light by liquid crystals is primarily a result of orientation fluctuations and is formally similar to the scattering by solid crystalline polymers. Some experimental results for the photographic scattering of mesophases of cholesteryl myristate are presented. The patterns for the cholesteric state are similar to those for spherulitic polymers and are analyzed using the theory for scattering from media exhibiting non-random orientation correlations. As a result of the light scattering studies it may be shown that the cholesteric state is characterized by disc-like correlations, while the smectic state and solid cholesteryl myristate both show random orientation correlations. Author (TAB)

N68-27179# North Carolina Univ., Chapel Hill. Dept. of Physics.
BASIC RESEARCH ON GRAVITATION Final Report, 1 Oct. 1966–30 Jun. 1967
Bryce S. DeWitt and Hendrik Van Dam 15 Mar. 1968 11 p refs
(Grant AF-AFOSR-153-67)
(AFOSR-68-0642; AD-668539)

This report describes recent contributions which have been made to both the canonical and covariant quantum theories of gravity. New results in the canonical theory include an analysis of the structure of the 'space of all 3-geometries,' a definition for the inner product of two state functionals, the quantum theory of the Friedman universe, an analysis of the fundamental differences between finite and infinite worlds, and an assessment of the meaning of a 'wave function for the universe.' New results in the covariant theory include use of a variable background metric, proof of Feynman's tree theorem, decomposition of radiative corrections into 'Feynman baskets,' use of fictitious quanta to secure a unitary and manifestly covariant S-matrix, an algorithm for dealing with the fictitious quanta in arbitrarily high order, various scattering cross sections, an analysis of the Ward identify and the Graviton vertex function, a coordinate-space calculation of vacuum polarization, and a proof of infrared problem. Author (TAB)

N68-27194# Michigan Univ., Ann Arbor. Radiation Lab.
INVERSE SCATTERING INVESTIGATION Quarterly Report, 3 Oct. 1967–3 Jan. 1968
Vaughan H. Weston, Wolfgang M. Boerner, and Dallas R. Hodgins Bedford, Mass. AFSC. Electron. Systems Div. Feb. 1968 96 p refs
(Contract F19628-67-C-0190)
(Rept.-8579-4-Q; ESD-TR-67-15, V. 4; QR-4; AD-668764)

The plane wave representation is generalized in terms of a three-dimensional Fourier transform, to yield an expression, which when combined with the incident field, gives the total electric field everywhere inside and outside non-magnetic scattering bodies. This representation requires the knowledge of the scattering matrix and its analytic continuation in the frequency domain. The use of short pulse data to determine the properties of uniformly coated bodies is considered, where the main attention is applied to the illuminated portion of smooth convex bodies at high frequencies. Computational results are obtained, establishing the conditions that are required to determine the surface of a conducting body from knowledge of the total near field. It is shown for the cases treated (sphere and prolate spheroid), that two separate conditions are required. One of these conditions yields a single surface which is an approximation to the proper surface, whereas, the other condition yields a set of surfaces, among which is the exact surface. Author (TAB)

N68-27221 Michigan Univ., Ann Arbor.
A COMPARISON OF PHOTOELECTRIC WITH PHOTOGRAPHIC MEASUREMENTS OF RELATIVE INTENSITIES OF SELECTED SPECTRAL LINES IN THE EXTREME ULTRAVIOLET
George Talbot Oser (Ph.D. Thesis) 1966 99 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8322

A condensed vacuum spark with 1/8" diameter aluminum electrodes was employed as a source of discrete radiation in the extreme ultraviolet region of the optical spectrum. A Bendix, open-window, resistance-strip magnetic photomultiplier on a movable carriage was guided along the 21 foot diameter Rowland circle of a spectrograph set at an 87° angle of incidence such that light intensities in the spectral region from 100 Å to 320 Å could be sequentially measured. The output of the photomultiplier was amplified and then integrated and displayed by an electrostatic voltmeter. Two spark conditions were chosen. The first condition yielded a peak current of 17 ka. This spark condition produced a high line intensity-to-background radiation ratio. The second spark condition produced a 30 kc peak current. A technique was developed to facilitate location of the spectral lines in the vacuum spectrograph and subsequent measurement of the intensity of the line profiles. Dissert. Abstr.

N68-27244# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HERALD OF LENINGRAD UNIVERSITY. MATHEMATICS, MECHANICS AND ASTRONOMY SERIES
V. I. Smirnov, ed. et al 23 Jun. 1967 230 p refs Transl. into ENGLISH of the Publ. "Vestnik Leningradskogo Universitaeta. Seriya Matematiki, Mekhaniki i Astronomii" Leningrad, Izd. Leningrad. Univ., 1964 p 1–168
(FTD-MT-64-357; AD-668820)

This document contains a collection of U.S.S.R. scientific articles in the fields of mathematics, mechanics, and astronomy. For individual titles, see N68-27245 through N68-27264.

N68-27311# Air Force Cambridge Research Labs., Bedford, Mass.
GREEN'S FUNCTIONS OF THE RYTOV EQUATION
Koichi Mano Jan. 1968 24 p refs *Its* Phys. Sci. Res. Papers No. 350
(PSRP-350; AFCRL-68-0029; AD-669060)

The Green's functions are calculated for the Rytov equation that governs the propagation of plane monochromatic waves in a random medium. The diverging as well as the converging wave solutions of the Green's functions are obtained for the two situations in which the Laplacian operator in the equation is either fully three-dimensional or only two-dimensional in the variables that describe the plane normal to the direction of wave propagation. The solutions found by Chernov and by Tatarski are compared with solutions that can be given in terms of the Green's functions thus obtained. Author (TAB)

N68-27338# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering.

APPROXIMATE PREDICTION OF MULTIMODAL CREST STATISTICS AND SYSTEM RELIABILITY FOR IMPULSIVE NOISE LOADING Final Report, 1 Dec. 1966–30 Oct. 1967

George L. Hedin, Raymond A. Janssen, T. I. Smits, and R. F. Lambert Wright-Patterson AFB, Ohio AF Mater. Lab. Feb. 1968 71 p refs
(Contract AF 33(615)-3365)
(AFML-TR-68-30; AD-668767)

The current analytical models of impulsive noise and system response thereto are found numerically intractable, indicating a need for engineering approximations. One, based on finding an 'equivalent' unimodal system having approximately the same response statistics—here the Crest statistics—is examined. It is found that fair agreement obtains, making it possible to use two reasonably accessible parameters to characterize any linear multimodal system response and thus predict its Crest statistics systematically, provided that 'standard' curves of unimodal response Crest statistics are available for statistically identical forcing. Limitations of this promising approach are explored, encouraging its use in reliability prediction pending further studies. Also, the need for further studies of impulsive noise response Crest distribution 'tails' is noted for prediction of overload and wearout reliability on the basis of wear-dependent failure rate concepts, since extrapolation of empirical data into the 'tail' (here done on the basis of a Weibull Crest Fit) is increasingly necessary the more 'impulsive' the response is (i.e., the more the parameter is less than unity). Author (TAB)

N68-27343# Naval Ordnance Lab., White Oak, Md.

ACOUSTIC RELATIONS FOR THE DESIGN OF HIGH-FREQUENCY ACOUSTIC TEST SYSTEMS

H. Gerber 16 Sep. 1967 17 p refs
(NOLTR-67-157; AD-668994)

General acoustic considerations that enter into the design of high-frequency acoustic test systems are given. Formulas are derived for computing the dimensions of required tanks in terms of the Maximum transducer size and the wavelength. The effects of reverberation are examined and the special advantages of wooden tanks are described. Author (TAB)

N68-27421 Michigan Univ., Ann Arbor.

THREE-PHASE, SOLID-LIQUID-VAPOR, EQUILIBRIUM IN THE SYSTEM HYDROGEN-HELIUM

Neil Edward Greene (Ph.D. Thesis) 1966 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8259

In this project, the pressure-temperature coordinates of the three-phase, solid-liquid-vapor, locus for the binary systems normal hydrogen-helium and equilibrium hydrogen-helium have been determined from the respective triple-points to pressures of approximately 250 psia. In addition, the low pressure bubble-point behavior of mixtures of helium have been determined for the system normal hydrogen-helium for temperatures between 15.6°K and the lower boundary of the three-phase surface. A comparison of the bubble-point behavior of the two hydrogen-helium systems was made for mixtures containing 0.3 mole % helium. Four isolated dew-point determinates were made for mixtures containing 90, 95 and 97 mole % helium for the normal hydrogen-helium system. The bubble-point and dew-point data were then used in conjunction with three-phase data in order to determine the compositions of the coexistent liquid and vapor phases located on the three-phase surface. Dissert. Abstr.

N68-27554*# Arkansas Univ., Little Rock.

MEASUREMENT OF THE INTENSITY OF TURBULENCE

M. K. Testerman [1968] 8 p refs
(Grant NGR-04-001-015)
(NASA-CR-95187) CFSTI: HC$3.00/MF $0.65 CSCL 20F

An experimental study was made to observe the effect of finite sampling volume on the apparent spectral broadening of the scattered light as observed by the Doppler heterodyne technique. This method, with several necessary modifications, may be suitable for measuring the scattering volume. An experiment was carried out to plot the velocity profile of laminar flow in a duct square cross-section. A Doppler shifted back-scattered beam was used in this study. Satisfactory results were obtained which indicated the suitability of the present setup for initial experimental studies on a turbulent free jet. Author

N68-27565# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

TWO DIMENSIONAL OPTICAL SUBTRACTION Final Report

S. M. Kovel May 1968 30 p refs
(CAL-RF-2455-0-1)

Single and multi-element electro-optic image subtractors were examined. Application of polarization control of photoconducting and electroluminescent materials proved the feasibility of the subtractors although strictly linear relationships could not be established between brightness output and difference in intensity inputs. Attempts to obtain a strictly planar panel were also unsuccessful. However, the latter problem probably will vanish with refinements in fabricating the subtractors. Author

N68-27575# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

JOURNAL OF APPLIED MECHANICS AND TECHNICAL PHYSICS

16 May 1967 322 p refs Transl. into ENGLISH of the book "Zhurnal Prikladnoy Mekhaniki i Tekhnicheskoy Fiziki" USSR, Izd. Nauka, 1964 p 1–168
(FTD-MT-65-161)

Soviet articles are presented on experimental and theoretical work in the areas of fluid mechanics, plasma physics, the mechanical and physical properties of polymers, thermodynamics, combustion physics, and shock wave phenomena. For individual titles, see N68-27576 through N68-27605.

N68-27668 Purdue Univ., Lafayette, Ind.

A METHOD FOR MODELING AND COMPENSATING NONLINEAR DYNAMIC SYSTEMS

Joseph Garth Thompson (Ph.D. Thesis) 1967 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-10263

Two problems encountered in the design of nonlinear systems are considered: the problem of modeling nonlinear physical systems and the problem of compensating nonlinear systems. These two problems are combined into a single problem called the design of an alterable system. The alterable system corresponds to the model in the modeling problem or to the compensated system in the compensation problem. Certain parameters of the alterable system are designated as alterable parameters corresponding to the free model parameters or to the adjustable parameters of the compensated system. A method is developed for obtaining the values of the alterable parameters which minimize the performance index as functions of one of the characteristic parameters. In the development of the method it becomes necessary to evaluate certain second partial derivatives of the index of performance Dissert. Abstr.

N68-27669# RAND Corp., Santa Monica, Calif.

INVARIANT IMBEDDING AND FREDHOLM INTEGRAL EQUATIONS WITH PINCHERLE–GOURSAT KERNELS

H. H. Kagiwada, R. E. Kalaba, and S. Ueno Apr. 1968 20 p refs
(Contract F44620-67-C-0045)
(RM-5599-PR; AD-668759)

An analytical procedure for solving Fredholm integral equations of the second kind with Pincherle-Goursat (degenerate) kernels is discussed. In the invariant imbedding approach used, the solution at a fixed value of t is studied as the length of the interval is varied. A Cauchy problem is derived, and it is verified that the initial-value method produces a solution of the integral equation. Such a procedure should prove a valuable alternative to the usual algebraic method, and should find application in signal detection, gas dynamics, radiative transfer, and mathematical biology.
Author (TAB)

N68-27727 California Univ., Los Angeles.
THE SCATTERING OF A SOMMERFELD-GOUBAU WAVE BY A PERFECTLY CONDUCTING ANNULUS
Edmond Stanley Gillespie (Ph.D. Thesis) 1967 109 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-9884

The scattering of a Sommerfeld-Goubau wave by a perfectly conducting plane annulus coaxial with a Goubau line is investigated both theoretically and experimentally. An integral equation for the current induced on the annulus is developed, and numerical methods are used to evaluate the current. A novel approach is used to enforce the edge conditions directly in the numerical solution. Incident to the development of the integral equation is the derivation of the Green's function for a ring dipole coaxial with the Goubau line. The bilateral Laplace transform is used to remove the z dependency of the differential equation. The inversion of the transformed solution is accomplished by first identifying the direct radiation, indirect radiation, and surface wave terms. Then, by use of known identities involving Hankel and Bessel functions, the direct radiation term is transformed into the vector potential solution for a ring dipole in free space. The surface wave term is easily obtained by evaluating the residue at the surface wave pole or by use of the reciprocity theorem. The computed current distribution for each of several annuluses is displayed graphically. Of particular interest is the current distribution computed for a very large annulus. The computed current for the various annuluses was used to compute their reflection coefficients.
Dissert. Abstr.

N68-27733 Michigan Univ., Ann Arbor.
ELECTROMAGNETISM IN MOVING, CONDUCTING MEDIA
Rudolph Morton Kalafus (Ph.D. Thesis) 1966 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8285

Based on Minkowski's theory of the electrodynamics of moving bodies, the present work is concerned with the systematic solution of problems involving sources placed in a uniformly moving, conducting medium. In order to accomplish this it is first necessary to examine the two differing forms of Ohm's law for moving media that are found in the literature. Another difficulty which is encountered when dealing with conducting media is related to the relaxation phenomenon. The total charge and current densities cannot be independently specified, but must be consistent with the relaxation phenomenon; for non-conducting media only the equation of continuity must be met. A scheme is developed here which involves a separation of currents and charges into source and response terms. The source terms can be specified independently, but the total charge must be consistent with Maxwell's equations. Vector and scalar potentials are developed from the field quantities, and partial differential equations for the potentials are derived for two classes of problems: static charge sources, and harmonic current sources.
Dissert. Abstr.

N68-27756# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HERALD OF LENINGRAD UNIVERSITY, VOLUME 18, NUMBER 19, 1963: MATHEMATICS, MECHANICS AND ASTRONOMY SERIES, NUMBER 4
1 Jun. 1967 220 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Mat., Mekh. i Astron. (Leningrad), 1963 p 1–156
(FTD-MT-64-146; AD-668523)

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9. ABOUT SYSTEM OF EQUATIONS OF VISCOUS LIQUID IN SPECIAL THEORY OF RELATIVITY N. B. Maslova p 110–133 refs (See N68-27765 16-12)

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N68-27764# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPTIMAL DERIVATION OF POINT ON TRAJECTORY, CORRESPONDING TO REQUIRED METHOD OF GUIDING [OPTIMAL'NYY VYVOD TOCHKI NA TRAYEKTORIYU SOOTVETSTVUYUSHCHUYU TREBUYEMOMY METODY NAVEDENIYA]

Yu. Z. Aleshkov *In its* Herald of Leningrad Univ.,Vol. 18, No. 19, 1963 1 Jun. 1967 p 101–109 refs (See N68-27756 16-23)

The plane motions of two points, C and C_1, whose locations at every instant T are given by corresponding vectors, are defined with two restrictive conditions. When during the motion of point C relative to point C_1 the first condition is satisfied, it is considered that point C is aimed at point C_1 by the pursuit method; when the second condition is satisfied, point C is considered aimed at point C_1 by the method of proportional navigation. The problem analyzed consists of determining a control function (trajectory) such that point C moves in the shortest time t, from the initial state onto a trajectory defined by the equation of motion with the corresponding restrictions. The optimal problems thus defined, corresponding to the two methods of aiming, are reduced to nonclassical variational problems, for whose solutions the Pontryagin maximum principal is applied. Two systems of simultaneous equations are derived. As a particular case, the transfer of a point C from the initial state into a plane circular trajectory with its center in the origin is analyzed with the condition that the velocity vector of C be oriented in the direction of the origin. A detailed solution is presented. The form of optimal trajectories is analyzed, and their dependence on the initial values of the phase point is shown. Author

N68-27768# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT APPROXIMATE INTEGRATION OF EQUATIONS OF DISTURBED MOTION IN THE CASE OF ONE SPECIAL ROOT [O PRIBLIZHENNOM INTEGRIROVANII URAVNENIY VOZMUSHCHENNOGO DUIZHENIYA V SLUCHAYE ODNOGO OSOBENNOGO KORNYA]

G. I. Mel'nikov *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 134–148 refs (See N68-27756 16-23)

The autonomous system of disturbed motion equations in case of the root equal to zero or to a small root is considered. A method of approximate integration of the system in the neighborhood of the coordinate origin is offered. Some error estimates of the approximate solution at the interval $0 \leq t < \infty$ are obtained. Author

N68-27769# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN STATISTICAL PROBLEMS PERTAINING TO ONE TYPE OF OBSERVATIONS [NEKOTORYYE STATISTICHESKIYE ZADACHI, OTNOSYASHCHIYESYA K ODNOMY TIPU NABLYUDENIY]

A. M. Kagan *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 175–177 refs (See N68-27756 16-23)

A plan is presented for solving certain problems of statistical inferences according to results of independent observations on ζ. It is assumed that $\zeta = (\xi,\eta)$ is a random vector, whose components ξ and η are independent. It is also assumed that the distribution function of random variable η H(x) is known, and the distribution function of random variable ξG(x) is unknown and will be estimated. Author

N68-27770# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MORE PRECISE DEFINITION OF ESTIMATE OF LEAST MEAN NUMBER OF COMPARISONS NECESSARY FOR COMPLETE ORDERING OF FINITE TOTALITY [UTOCHNENIYE OTSENKI NAIMEN'SHEGO SREDNEGO CHISLA SRAVNENIY, NEOBKHODIMYKH DLYA PRLNOGO UPORYADOCHENIYA KONECHNOY SOVOKUPNOSTI]

S. S. Kislitsyn *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 178–181 refs (See N68-27756 16-23)

There are n different objects. All possible orders of the objects by weight give equal probabilities 1/n!. The following plan of paired comparisons is considered: let the k objects be already ordered completely. Then the place of the (k+1)-th object is found in the shortest (in the mean) way. The asymptotic formula is obtained from the average number of tests which are necessary for the complete ordering of the set by the method described. Author

N68-27801 Chrysler Corp., Huntsville, Ala. Space Div.

A NOTE ON THE DEVELOPMENT OF PERTURBATION EQUATIONS AND STATE TRANSITION MATRICES FOR LINEAR FILTERS

G. P. Herring and C. E. Nickel 27 Oct. 1967 26 p refs (HSM-M106-67)

The classical method for the linearization of systems of second order differential equations and the solution of the so-called perturbation equations and the resulting transition matrix are presented. Also discussed is a new approach to problems in linear filtering where the linearization is accomplished by determining linear approximations of the dynamical system, which are best in the sense of least squares. Author

N68-27813 Rutgers Univ., University Park, N. J.

MAGNETIC BEHAVIOR OF SINGLE-DOMAIN PARTICLES

Ronald Moskowitz (Ph.D. Thesis) 1967 102 p

Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9257

Demagnetization tensors are introduced that are valid for any sample shape. Examination of the properties of these tensors shows that the magnetic behavior of a sample can be represented by an ellipsoid of the same nominal dimensions as the particle. It is shown how to determine the exact equivalent ellipsoid of any sample and the method is demonstrated on several polygonal cylinders. A magnetometric demagnetization tensor is defined for uniformly magnetized samples of arbitrary geometry. It is shown that this is a real symmetric tensor with nonnegative diagonal elements and unit trace. Diagonalization of the magnetometric demagnetization tensor yields the Brown-Morrish equivalent ellipsoid and the conclusion that Stoner–Wohlfarth particles of any surface geometry have either only two easy directions of magnetization or are isotropic. Dissert. Abstr.

N68-27824# Oesterreichische Studiengesellshaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Metallurgie.

LIQUID HELIUM STAGE WITH A TRANSVERSE MAGNETIC FIELD

E. M. Hoerl 1968 10 p refs Submitted for publication (SGAE-M-14/1968) CFSTI: HC$3.00/MF$0.65

A stage for the observation of specimens in an electron microscope at liquid helium temperature is described. This stage is characterized by the addition of a transverse magnetic field in which the specimen is positioned. Provisions are made for tilting the specimen around two axes, which are perpendicular to each other. Author

N68-27829 Purdue Univ., Lafayette, Ind.

DOPPLER EFFECT EVALUATION BY A MODIFIED P_n METHOD

Hussein Yahya Fouad (Ph.D. Thesis) 1967 213 p

Available from Univ. Microfilms: HC $9.70/MF $3.00 Order No. 67-10191

A modified P_n method has been developed to calculate the Doppler Effect for systems in which there is anisotropic scattering and nonuniform temperature distributions. By means of a matrix transformation it is possible to decouple the differential equations which result from the P_n or S_n decomposition of the Boltzmann neutron transport equation. As a result of this decoupling, it is possible to obtain an alternative solution. A computer code has been written in FORTRAN IV language. Results from sample calculations indicate that the uniform effective temperature distribution approximation in fuel may underestimate the Doppler Effect for thick elements. Dissert. Abstr.

N68-27831 Johns Hopkins Univ., Baltimore, Md.

THE UNIT-CELL THEORY OF A CLASS OF DIFFRACTION GRATINGS FOR S POLARIZATION

Frank Mathild Nelson (Ph.D. Thesis) 1967 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-9578

A theory for the behavior of parallel-line diffraction gratings is described. The principal features of the spectral intensities, as functions of the angle of incidence, are shown to be attributable to the behavior of a single unit-cell of the periodic structure of the grating, coupled with the behavior of adjoining unit-cells under the influence of initial diffraction along the plane of the grating from the parental unit-cell. Within the constraints of the simplifying assumptions, the peculiar behavior of the spectral intensities, known as Wood's anomalies, is shown to arise naturally as a feature of the unit-cell theory. Dissert. Abstr.

N68-27846 New Mexico State Univ., Las Cruces.

THE DIELECTRIC CONSTANT OF WATER AND SUPERCOOLED WATER FROM −5°C TO 25°C

Edmund William Rusche, Jr. (Ph.D. Thesis) 1966 161 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-9479

The static dielectric constant of water, ϵH_2O, has been obtained at fifty-nine temperatures over the temperature range −5.13°C to 25.08°C. Values of ϵH_2O in the supercooled region, which previously did not exist with the accuracy achieved in this work, have been determined to a temperature of −5.13°C and the temperature characteristics of two prominent theories of the structure of water examined in comparison with these experimental results. A study of the thermal behavior of ϵH_2O over the entire temperature range covered was conducted by statistical methods to determine if any abrupt change occurred in the structure of water. Interest was particularly directed to the supercooled region around 0°C and to the region around +15°C. Results showed no abrupt change in the structure was evident at temperatures from −3.5°C to 22°C. Dissert. Abstr.

N68-28075# United Kingdom Atomic Energy Authority, Culham (England).

RANDOM INSTABILITY OF NONLINEAR OSCILLATIONS

G. M. Zaslavskii Sep. 1967 15 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. i Techn. Fiz. (Moscow), no. 2, 1967 p 16–22
(NP-TR-1625; CTO-426)

A dynamic system is investigated whose behavior in time is described by $x'' + \omega_0^2 (1 + \alpha x^2) x + F(t)x = 0$ where an external force F(t) is very near periodical with frequency $\Omega << \omega_0$. Systems of this type, provided the non-linearity parameter α is sufficiently small, preserve a conditionally periodic motion. The solution can be represented in the form of a quasi-periodic motion with significantly varying phase. The determination of the criterion by which the dynamic system may be approximately described by statistical laws is combined with an explanation of the condition under which the time correlations of the phase decrease exponentially. It is necessary to show at what point in time the phase sequence in time may be considered approximately as a succession of random numbers. An asymptotic method is proposed for determining the randomness criterion for a motion of this type, and which is also applicable to slightly more complex systems. The proposed method cannot be described as mathematically exact. Certain regions, although from the physical point of view appear quite natural, may require some more exact justification. NSA

N68-28134 Brown Univ., Providence, R. I.

ULTRASONIC RADIATION FIELD OF A FOCUSING SPHERICAL SOURCE AT FINITE AMPLITUDES

Carl Walter Smith (Ph.D. Thesis) 1966 64 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2290

A PZT-4 ceramic spherical segment with a radius of curvature of 30 cm has been used to produce a finite-amplitude ultrasonic field in water at a frequency of 2.2 Mc/s. The field has been observed by a non-resonant probe with an active face of 1/8 in. diameter. The radiation field differs from that expected from an unbounded source since edge effects are present. This was noted for the low amplitude case by A. O. Williams, Jr. (J. Acoust. Soc. Am. 17, 219 (1946)) and H. T. O'Neil (J. Acoust. Soc. Am. 21, 516 (1949)) who showed that the axial values of pressure amplitude from a spherical segment resembled those from a plane piston which is modulated by a reciprocal r term. The theoretical work of K. A. Naugol'nykh, S. I. Soluyan, and R. V. Khokhlov (Soviet Physics-Acoustics 9, 42 (1963)) on the unbounded case and its application to the bounded case is discussed. Experimentally, harmonic radiation patterns for the fundamental component in the finite-amplitude case were found in general to be similar to those for the infinitesimal case, but differed somewhat in detail. The higher harmonics have also been measured both along the beam and transverse to it. Dissert. Abstr.

N68-28221# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

THE ELECTROSTATIC POTENTIAL BETWEEN A CIRCULAR CYLINDER AND A SQUARE CYLINDER

N. N. Selander Apr. 1968 31 p
(AECL-3110) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

A semianalytic method is given for finding the two-dimensional potential between coaxial circular and square cylinders. Good accuracy is obtainable and numerical estimates for the maximum error are given. The capacitance of the configuration is obtained and is compared with the capacitance of related pairs of concentric circular cylinders. The results obtained are directly related to problems in heat transfer and transmission line wave propagation. Author

N68-28259*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

AN EXPLANATION OF FITZGERALD'S AUDIOFREQUENCY RESONANCES AND SOUND BEAMS

Donald R. Behrendt and James P. Cusick Washington Jun. 1968 12 p refs
(NASA-TN-D-4625) CFSTI: HC $3.00/MF $0.65 CSCL 20A

Fitzgerald's method is used to investigate the origin of his audiofrequency resonant phenomena. The source of the phenomena is shown from experiment to arise from the stiffness of the sample-shaker interface and not from a process associated with the interior of the sample, as proposed by Fitzgerald. The resonance effects are explained in terms of conventional elastic theory. Author

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N68-26969# Illinois Univ., Urbana. Dept. of Physics.

EQUAL MASS CONSPIRACY RELATIONS AS THE LIMIT OF THE UNEQUAL MASS CASE

John D. Stack [1968] 31 p refs
(Contract N00014-67-A-0305-0005)
(AD-668537)

It is proven that conspiracy relations for equal mass scattering are always the limits of the linear relations among helicity amplitudes for the unequal mass case. The proof is illustrated by detailed consideration of the 'pion + rho meson to n + anti-n' reaction. Author (TAB)

N68-27019# Harry Diamond Labs., Washington, D. C.
SPIN-ORBIT REDUCED MATRIX ELEMENTS
Michael Buas and N. Karayianis Mar. 1968 31 p refs
(HDL-TR-1380; AD-668656)

The spin-orbit interaction in a configuration of the form (nl)(N) is considered in detail. An explicit expression for the reduced matrix element of the interaction for Russell-Saunders ground states is obtained. Reduced matrix elements involving the ground term of the (nf)(6) configuration and excited terms to which it couples are given. A general proof is given of the known relationship between matrix elements of complementary configurations.
Author (TAB)

N68-27042# Illinois Univ., Urbana. Dept. of Physics.
HARMONIC OSCILLATOR MODEL FOR BARYONS
David Faiman and Archibald W. Hendry 9 May 1968 41 p refs
(Contract N00014-67-A-0305-0005)
(AD-669115)

Attention is drawn to a possible band structure displayed by the known N* resonances. The observed spectrum is similar to that predicted by a paraquark harmonic oscillator shell model. Exact three-body Schrodinger wave functions are used to compute the N-pi and Delta-pi partial decay widths, assuming the pion emission takes place via a one-quark de-excitation. The agreement with experiment is very good.
Author (TAB)

N68-27044# Atomics International, Canoga Park, Calif.
LEGENDRE EXPANSION COEFFICIENTS FOR THEORETICAL ANGULAR DISTRIBUTIONS OF ELASTICALLY SCATTERED NEUTRONS
R. Campbell, H. Alter, R. Berland, and V. Luco 1 Mar. 1968 34 p refs
(Contract AT(04-3)-701)
(NAA-SR-12533) CFSTI: HC$3.00/MF$0.65

Theoretically calculated angular distributions for elastically scattered neutrons were analyzed in terms of Legendre polynomial expansions. The theoretical calculations were performed by Agee and Rosen (LA-3538-MS, Vols. I and II) and were based on combined optical model and Hauser-Feshback theory. From their results, thirty-six isotopes, ranging in mass from sodium to plutonium-240, were analyzed. The resulting Legendre expansion coefficients have been forwarded to Brookhaven National Laboratory (BNL) in an ENDF/A compatible format, and are available from the National Neutron Data Center (NNDC) at BNL on request.
Author (NSA)

N68-27056# Massachusetts Inst. of Tech., Cambridge. Nuclear Science Lab.
A LIMIT ON THE BRANCHING RATIO, $K^+ \rightarrow X^+ + \gamma$.
D. Friedall, M. Deutsch, D. Cutts (Calif. Univ., Berkeley. Lawrence Radiation Lab.), R. Stiening (Calif. Univ., Berkeley. Lawrence Radiation Lab.), and C. Wiegand (Calif. Univ., Berkeley. Lawrence Radiation Lab.) Dec. 1967 8 p
(Contract AT(30-1)-2098)
(MIT-2098-389)

As a part of the Bevatron spark chamber study of K+ decays at rest, data were searched for examples of the decay $K+ \rightarrow X+ + \gamma$ where X+ is any long-lived charged particle in the mass range covered, and in particular for the forbidden decay $K+ \rightarrow \pi+ + \gamma$. No statistically significant evidence for the existence of these decay modes was found. Candidates were recognized by the relation of the conversion point of a gamma ray to the track of a charged particle. The apparatus was sensitive to decays of the form $K+ \rightarrow X+ + \gamma$ for hypothetical particles X+ having a mass in the interval 183 MeV $< m_{X}+ <$ 202 MeV and in the interval 133 MeV $< m_{X}+ <$ 148 MeV. Assuming that the hypothetical particle X+ reaches the end of its range without nuclear interactions, one can set an upper limit on the branching ratio for this decay of 3.7×10^{-5} for particles in the latter mass range and 2.6×10^{-5} for particles in the former mass range. If nuclear interactions are included, these limits become 1.52×10^{-4} and 4.4×10^{-5}, respectively. For the specific decay $K+ \rightarrow \pi+ + \gamma$ one can set an upper limit on the branching ratio of 5.6×10^{-5}.
Author (NSA)

N68-27079 California Univ., Berkeley.
PION-NUCLEON SCATTERING IN THE P_{11} STATE
John Henry Schwarz (Ph.D. Thesis) 1966 59 p Sponsored by NSF
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-5162

The P_{11} pion-nucleon scattering amplitude is studied in order to determine the dynamical status of the nucleon. A simple one channel static model is constructed in which a good fit to the low energy data is obtained with a CDD pole. If there is, in fact, such a pole, with the strength indicated by our model, then one must conclude that other channels play a significant, although not overwhelming, part in forming the nucleon. It is also possible to reconcile all the available information with a model containing no CDD poles in which the nucleon is formed to a good approximation in the pion-nucleon channel alone. It is shown how the success of certain "reciprocal bootstrap" calculations can be understood, whether or not a CDD pole is required. Dissert. Abstr.

N68-27098 California Univ., Berkeley.
ENVIRONMENTAL EFFECTS ON THE DECAY CONSTANT OF Nb^{90m1}
John Arthur Cooper (Ph.D. Thesis) 1966 147 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8546

A method has been developed to study changes in nuclear decay constants due to alterations in the chemical or physical enviroment. This method has been applied to the study of the effect of chemical state changes, the effect of a large increase in pressure and the effect of changes into and out of the superconducting state on the decay constant of the 24-second isomeric state in Nb^{90}. The gamma-ray spectrum of Mo^{90} has also been investigated. Several new lines have been observed and the photon intensities have been measured. The multipolarities of many of the intense transitions have been determined and their coincidence relationships resolved with gamma-gamma coincidence studies. A decay scheme has been postulated from which the energy of the transition depopulating the 24-second isomeric state has been determined from energy differences to be 2.38 ± 0.37 keV. Dissert. Abstr.

N68-27105# Illinois Univ., Urbana.
MONTE CARLO CALCULATION OF THE SPECTRUM OF GAMMA RADIATION FROM A COLLIMATED CO-60 SOURCE Final Report, Sep. 1966–Dec. 1967
E. E. Morris and A. B. Chilton Dec. 1967 59 p refs *Its* Nucl. Radiation Shielding Studies Rept. No. 6
(Contract N00228-66-C-0311)
(NRDL-TRC-68-6; AD-669120)

A Monte Carlo calculation of the energy spectrum emitted by a collimated, Co-60 source is reported. The collimator assumed is very similar to one currently being used in experimental shielding studies at the University of Illinois. Radiation emerging from the collimator is classified into 13 equal-length energy intervals between 0.1 and 1.4 MeV, and into 3 direction intervals for angles relative to the collimator axis between 0 and 90 deg. Comparisons are made with experimental and theoretical work reported by others.
Author (TAB)

N68-27124 California Univ., Berkeley.
MEASUREMENTS ON NEUTRON SCATTERING RESONANCES IN FISSIONABLE NUCLEI
George Dimeling Sauter (Ph.D. Thesis) 1966 170 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-8645

A new technique for making measurements on neutron scattering resonances has been developed which allows measurements on fissionable nuclei, where scattering is a very small fraction of the total resonance cross section. The method has been successfully used for measurements on Pu^{239}, Pu^{241}, and U^{233}. The main feature of the technique is the use of a pulsed uniform 4π neutron source which surrounds the scattering sample. Time-of-flight methods are used to detect and measure the energy of those neutrons which are scattered into a fixed small solid angle increment. Fission neutrons and fission and capture gamma rays, which are a large source of background in scattering experiments using a mono-directional incident neutron beam and a detector around the scattering sample, are thus easily timed out, making the measurement much more sensitive to the scattered neutrons. Using this technique, total angular momentum (spin) assignments have been made for the levels of the compound Pu^{240} nuclei formed when a neutron interacts with one of 15 resonance levels of Pu^{239} below 60 eV. Dissert. Abstr.

N68-27137# Stanford Univ., Calif. Linear Accelerator Center.

FADDEEV'S EQUATIONS FOR LOCAL POTENTIALS

T. A. Osborn Dec. 1967 129 p refs
(Contract AT(04-3)-515)
(SLAC-79) CFSTI: HC $3.00/MF $0.65

Solutions of Faddeev's equations for an arbitrary potential are derived and are used to test the validity of the assumption that two-body potentials can be represented as separable potentials. The equations for the three-body problem are simplified; the number of independent variables is reduced from six to two by expanding the system in terms of a complete set of angular momentum wave functions. A two-variable integral equation is thereby obtained, and numerical techniques are developed with which this integral equation can be represented as a finite matrix problem. Binding energies and wave functions for a system of three identical particles are obtained using nonseparable exponential and Yukawa potentials. The system manifests a number of three-body bound states depending on the strength of the two-body attraction. The bound-state wave functions are described. It is found that the separable approximation is useful only in the limit in which the two-body forces are weak. NSA

N68-27143 Minnesota Univ., Minneapolis.

A STUDY OF LOW ENERGY INTERACTIONS IN THE KAON NUCLEON SYSTEM

Chanock Weil (Ph.D. Thesis) 1966 78 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-7800

An attempt at comparing experimental kaon nucleon scattering data with predictions of a forward scattering dispersion relation is made. We integrate both K−p and K+p total cross section data, related by crossing symmetry. As of today, the K−p and K+p total cross sections do not coincide in the high energy limit. The implications of such behavior are discussed. We indicate whatever dependence our results may have on a specific choice of the parameters. We analyze only the "strong" part of the $\bar{K}N$ interaction, and concentrate our attention on the relatively well known low energy region between the $\bar{K}N$ threshold and the Y_o^* (1520) resonance. First, a straighforward extension of the Dalitz–Tuan S-wave zero-effective-range formalism is used to account for the unphysical region below the $\bar{K}N$ threshold. The second part of this work contains two theoretical models in which large breaking in the Y_o^* BP couplings may result. The first is a four-channel Schrodinger-type semi-relativistic calculation, based on a vector meson exchange interaction. Dissert. Abstr.

N68-27144 California Univ., Berkeley.

STUDY OF BRANCH POINTS IN THE ANGULAR MOMENTUM PLANE

Heinz Jurgen Rothe (Ph.D. Thesis) 1966 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-6640

A study is made of the Amati, Fubini, Stanghellini (AFS) type of approximation to the amplitudes associated with the exchange of a single Regge pole and an elementary spinless particle, and of two Regge poles, respectively. The location, motion, and nature of the singularities in the complex angular momentum plane of the s reaction which appear in these approximations, and their cancellation in the full diagram, are considered in detail; the singularities are found to be of two general types: branch points whose positions are independent of particle masses, and those which depend on them. Dissert. Abstr.

N68-27157 California Univ., Berkeley.

A COMPARISON OF THE POSITIVE AND NEGATIVE MUON DECAY SPECTRA IN COPPER

Philip Bert Beilin (Ph.D. Thesis) 1966 111 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8522

Negative muons from a synchrocyclotron were stopped in a copper plate target. The momenta of the decay electrons were measured by an Elbek type wide gap, broad range, magnetic spectrometer. Eleven scintillation counters served to define the focal plane for trajectories from the target, through the spectrometer, to the focal plane. For comparison, positive pions were stopped in the copper target giving rise to positive muons upon their decay. The positrons from subsequent positive muon decay were momentum analyzed under the same experimental conditions as the electrons. The measured positive and negative electron momenta spectra are compared to the theoretical predictions taking into account energy loss straggling and various other experimental resolution effects. Dissert. Abstr.

N68-27159 California Univ., Berkeley.

A STUDY OF RESONANCE PRODUCTION AND DECAY, AND ELASTIC SCATTERING IN NEGATIVE PION PROTON TWO-PRONG INTERACTIONS AT 2.05 TO 3.22 GEV/c

Laurance David Jacobs (Ph.D. Thesis) 1966 199 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-6581

We present an analysis of 45 000 $\pi^- p$ interactions in the Alvarez 72-inch hydrogen bubble chamber resulting in two charged particles. The reactions $\pi^- p \rightarrow n\,\pi^+\pi^-$ and $\pi^- p \rightarrow p\pi^\circ\pi^-$ and elastic scattering have been studied at 2.05, 2.17, 2.36, 2.60, 2.86, and 3.22 GeV/c. We find that the three-body interactions are dominated by production of the ρ meson. We have used the OPE model, modified by absorption, to calculate and fit the production and decay angular distributions of the ρ and to estimate the s-wave contribution to $\pi\pi$ scattering. We have fitted the diffraction peak in $\pi^- p$ elastic scattering to an exponential form and find that between 2.0 and 2.5 GeV/c the exponential slope varies. This behavior is linked to the presence of resonances in the s channel. The fast decrease of the secondary peak is linked to the exchange of the P′ Regge trajectory in the t channel. Evidence is shown for production of the A_2^- in $\pi^- p \rightarrow \pi^- p$ + missing mass. Dissert. Abstr.

N68-27163 Brown Univ., Providence, R. I.

THE INTERACTION OF 14.1 MeV NEUTRONS WITH TRITONS

Joseph Mailen Kootsey (Ph.D. Thesis) 1966 95 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-2256

A thin tritium target was bombarded by 14.1 MeV neutrons and the outgoing protons, deuterons, and tritons studied with a specially designed and constructed counter telescope and electronics system. The double proportional counter-scintillator telescope featured special provisions for eliminating effects from the natural tritium beta particles and, with the associated electronics, was able to distinguish between protons, deuterons, and tritons. An angular distribution for n-T elastic scattering was obtained for neutron angles of 55° to 180° in the c.m. system. This distribution was compared with previous resonating group structure calculations of elastic scattering for the purpose of comparing the relative merits of the Serber and symmetric exchange mixtures and the inclusion of other force types. The best fit was provided by the Serber mixture with the possible inclusion of some spin-orbit forces. Deuterons from the breakup reaction T(n,d)2n were detected at $\theta_{lab} = 0°$ and the spectrum fitted by the final state interaction system. Because of a high proton background, no charged particles from T(n,p)3n were observed. Dissert. Abstr.

N68-27167 California Univ., Berkeley.

EQUILIBRIUM PROPERTIES OF BOSON SYSTEMS AT LOW TEMPERATURES

Victor Kenneth Wong (Ph.D. Thesis) 1966 284 p
Available from Univ. Microfilms: HC $12.85/MF $3.65 Order No. 67-8674

A study of the equilibrium properties of boson systems at low temperatures with particular emphasis on the Bose-Einstein transition and restricted geometry is undertaken both from the microscopic and the macroscopic viewpoints. Use of the Green's function formulation enables the systematic study of essentially all microscopic models in the literature. In particular the zeroth-order approximation is the Ideal Bose gas, which is applied to the problem of restricted geometry. The first-order approximations include the Bogoliubov/Ideal, Hartree, Bogoliubov/Hartree, Hartree-Fock, and Bogoliubov/Hartree-Fock approximations. The Born-Collision approximation is applied to restricted geometries by a variational technique. Dissert. Abstr.

N68-27183 California Univ., Berkeley.

INELASTIC COLLISIONS OF THE SECOND KIND BETWEEN ELECTRONS AND EXCITED MERCURY ATOMS

Paul David Burrow (Ph.D. Thesis) 1966 64 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-8533

The relative cross section for inelastic collisions of the second kind between electrons and mercury atoms in the excited $^3P_1$ state was measured as a function of electron energy. Excited atoms were produced by absorption of the 2537 Å resonance radiation from a mercury arc. A low energy beam of electrons with good resolution was produced by using the retarding potential difference method. Electrons which made collisions with excited atoms could gain kinetic energy by leaving the atoms in the ground state. These faster electrons were detected by passing them through a potential barrier which reflected unscattered electrons. The data are in good agreement with the cross section computed by applying detailed balancing to the known cross section for excitation to the $^3P_1$ state by electron impact. Dissert. Abstr.

N68-27187 Michigan Univ., Ann Arbor.

πp ELASTIC SCATTERING FROM 2.3–6.0 BeV/C WITH SPECIAL REFERENCE TO THE BACKWARD DIRECTION

David Gerald Williams (Ph.D. Thesis) 1966 80 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-8365

Results are presented for 7 runs of π^+p elastic scattering with π momentum from 2.3 to 4.0 BeV/c, and for 5 runs of π^-p with momentum from 2.5 to 6.0. Differential cross sections were obtained for $\cos\theta^* = +.97$ to $-.94$. Experimental data was obtained with spark chambers, and a fully automatic scanning system was used in the analysis. The differential cross section in the region behind the two forward peaks is discussed. A calculation based on the formation of intermediate N* states is presented. The backward peak may be calculable on the basis of exchange of Regge trajectories, plus N* formation. The cross section for $\pi^-p \rightarrow \bar{p}d$ at 6 BeV/c is found to be less than 9.1 μb. Slopes of the backward peaks are presented, as well as upper and lower bounds for $\pi^-p \rightarrow \pi^0 n$. Dissert. Abstr.

N68-27209 University of Southern Calif., Los Angeles.

THE CALCULATION OF RESONANT STATES OF ATOMS AND MOLECULES BY QUASI-STATIONARY METHODS

James Kendree Williams, Jr. (Ph.D. Thesis) 1966 211 p
Available from Univ. Microfilms: HC $9.70/MF $3.00 Order No. 67-8038

Quasi-stationary methods of calculating the energy of core-exciting and single particle resonances and auto-ionizing states of atoms and molecules are presented both from an intuitive, physical approach and from a formal, rigorous standpoint. The method is applied to resonant states of H_2^-, and in the process, a general computer program for calculating the energies and wave functions of diatomic molecules which incorporates both the normal variation method of quantum chemistry for bound states and the quasi-stationary method for resonances has been developed. The results of the H_2^- calculations are compared with electron scattering experiments. The diatomic molecule program is a modernization of previous methods and includes several new options; it is extended so that calculations can be done for up to twenty electrons. A sample calculation on NO+ is presented as an illustration of the applicability of the program to calculations on large diatomic systems. Dissert. Abstr.

N68-27229*# Oak Ridge National Lab., Tenn.

COMPARISONS OF RESULTS OBTAINED WITH SEVERAL PROTON PENETRATION CODES, PART 2

W. Wayne Scott and R. G. Alsmiller, Jr. Jun. 1968 27 p refs
(NASA Order R-104(10); Contract W-7405-ENG-26)
(NASA-CR-95141; ORNL-RSIC-22, Pt. 2) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Comparisons of the results obtained for a hypothetical problem with four different proton penetration codes have previously been presented in ORNL-RSIC-17. In this report, similar comparisons obtained with two additional proton penetration codes, CHARGE written by J. R. Lilley and W. R. Yucker and ASTROS written by R. Wallace, P. G. Steward, and C. Sondhaus, which have been added to the code collection of the Radiation Shielding Information Center, are presented. The hypothetical problem considered is to find the dose as a function of depth in tissue when a typical solar-flare proton spectrum is incident on a semi-infinite slab of aluminum followed by tissue and to find the dose as a function of depth when monoenergetic protons are incident on a semi-infinite slab of tissue. Author

N68-27236 California Univ., Berkeley.

ANALYTIC HELICITY AMPLITUDES AND REGGE-POLE FORMULAE FOR DIFFERENTIAL CROSS SECTIONS

Ling-Lie Chau Wang (Ph.D. Thesis) 1966 58 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8666

A simple and straightforward method to identify and remove the kinematic singularities of helicity amplitudes is constructed from the Trueman–Wick crossing relations. A set of amplitudes free of all kinematic singularities and zeros is obtained for two-particle → two-particle reactions of any spin and masses except for boson–fermion interactions. It is shown that for boson–fermion interactions with general mass assignment there is always a kinematic $S^{1/2}$ singularity left in the amplitude. Therefore it is natural to consider the amplitudes of boson–fermion interactions as functions of $S^{1/2}$ instead of S. The amplitudes obtained by the above method are suitable for Reggeization and their residue functions are free of kinematic singularities. Regge pole formulae for differential cross sections of some quasi two-body πN and NN interactions, which can have one or two meson trajectories exchanged, are given in this paper. Dissert. Abstr.

N68-27237 California Univ., Berkeley.

RESONANCES IN THE REACTION $K^-n \rightarrow \Sigma^-\pi^+\pi^-$ FROM 1660 MeV TO 1900 MeV

Robert Brooks Bell (Ph.D. Thesis) 1966 84 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8523

We have studied the reaction K− n → Σ− π+π− in the K−n center of mass energy range from 1660 MeV to 1900 MeV. Three strangeness minus one baryon resonances are definitely observed. Two of these isobars, the $Y_0^*(1520)$ and $Y_0^*(1405)$ are produced with the negative pion and then decay into the Σ−π+ final state. The third, the $Y_1^*(1760)$, undergoes the decay $Y_1^*(1760) \rightarrow Y_0^*(1520)$ π−. The Σ−π− final state has isospin two and an extensive search was made for any enhancement which might indicate the presence of a Y_2^*. No evidence for the existence of a doubly charged strange resonance decaying into Σ−π− was found anywhere in the available energy region of this experiment. It was possible to unambiguously determine the spin and parity of the $Y_1^*(1760)$ by an examination of the production angular distribution of the $Y_0^*(1520)$ produced in the reaction K−n → $Y_1^*(1760) \rightarrow Y_0^*(1520)$ π− and the decay distribution of the $Y_0^*(1520)$ into $\Sigma^-\pi^+$. Dissert. Abstr.

N68-27341# Cambridge Univ. (England). Cavendish Lab.

RESEARCH ON THEORETICAL HIGH ENERGY PHYSICS AND QUANTUM THEORY OF MANY PARTICLE SYSTEMS

Final Scientific Report, 1 Nov. 1965–30 Sep. 1967

Richard J. Eden 27 Dec. 1967 10 p refs
(Grant AF-EOAR-65-36)
(AFOSR-68-0910; AD-669142)

Theoretical research has been carried out in the following main areas in the theory of elementary particles: (a) S matrix theory, especially developments based on causality, unitarity and analyticity. (b) Regge theory and high energy collisions, especially symmetry properties, conspiracy and evasion by Regge poles. (c) Sum rules, especially work relating to Fubini sum rules and Weinberg sum rules. (d) Current algebra and weak interactions. Author (TAB)

N68-27344 Pennsylvania Univ., Philadelphia.

THE $^{16}O(^3He,N)^{18}Ne$ DOUBLE STRIPPING REACTION

Merlyn Stewart Krick (Ph.D. Thesis) 1966 158 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-7652

An eleven MeV ^3He beam from a tandem Van de Graaff accelerator was used for the study of the $^{16}O(^3He,n)^{18}Ne$ reaction. The neutrons were detected with a double scatter time-of-flight spectrometer. The target was a cell of oxygen gas. Neutrons were measured for the ground and first excited state transitions at eight laboratory angles from six to fifty degrees. The resulting angular distributions were analyzed with Newns' plane wave double stripping theory. The ground state transition was well fitted with L=0, implying 0+ for the ^{18}Ne ground state; the first excited state transition was well fitted with L=2, implying 2+ for the 1.88 MeV level of ^{18}Ne. The peak cross sections in the angular distributions were found. These results are compared with predictions of the diffraction model and distorted wave theories of Henley and Yu, low energy $^{16}O(^3He,n)^{18}Ne$ ground state angular distribution data, and absolute cross sections and angular distributions for the mirror reaction $^{16}O(t,p)^{18}O$. Dissert. Abstr.

N68-27345 Michigan Univ., Ann Arbor.

π−p ELASTIC SCATTERING AT 180 DEGREES FROM 1.6 TO 5.3 GeV/c

Stephen William Kormanyos (Ph.D. Thesis) 1966 85 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-6290

We have measured the differential cross section for π−p elastic scattering at 180° in steps of 0.10 GeV/c or less in the region from 1.6 to 5.3 GeV/c. There is considerable structure in the cross section. This may be interpreted as an interference effect between the resonance amplitude and the non-resonant or background amplitude. There is a dramatic destructive interference at P_0 = 2.15 GeV/c which is quite interesting as the cross section drops almost two orders of magnitude in this region. Another interesting feature of the experiment is the large narrow peak in the cross section at P_0 = 5.12 GeV/c. We believe that this is firm evidence for the existence of a nucleon resonance with a mass of (3245 ± 10) MeV. This N* (3245) has a full width at half-maximum of less than 35 MeV. The width of the resonance is about 1% of its mass. Parities and the quantity X(J + 1/2) are given for various N* resonances where X is the elasticity and J is the spin of the resonance. Dissert. Abstr.

N68-27346 Florida State Univ., Tallahassee.

ISOBARIC-SPIN ANALOGUE RESONANCES IN ZIRCONIUM-90 FROM PROTON INELASTIC SCATTERING

Dale Donald Long (Ph.D. Thesis) 1966 108 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8472

Compound nucleus resonances have been observed in Zr^{90} through the reaction $Y^{89}(p,p')Y^{89*}$. These resonances have been interpreted as isobaric-spin analogues of low-lying levels in Y^{90}. The experiment was performed using a 12 MeV tandem Van de Graaff accelerator. The outgoing protons from the reactions were analyzed in a broadrange magnetic spectrograph. Excitation functions for incoming proton energies between 5.5 and 11 MeV were taken for the four cases in which the residual nucleus was left in each of the first four excited states. Angular distributions were taken. The results were analyzed in terms of a general expression for the differential reaction cross-section which was written in terms of an undefined scattering matrix. The j-j coupling scheme was used. Tentative assignments were made for the spins, parities and orbital angular momentum values for the observed resonances. Dissert. Abstr.

N68-27444*# Columbia Univ., New York. Radiation Lab.

FAILURE OF THE ADIABATIC CRITERION; STRUCTURE AND COHERENCE IN THE LOW ENERGY EXCITATION OF HELIUM ATOMS BY HELIUM IONS

S. Dworetsky, R. Novick, W. W. Smith, and N. Tolk Mar. 1967 11 p refs Presented at the Intern. Conf. on the Phys. of Electron. and Atomic Collisions, Leningrad, 17–23 Jul. 1967
(Grant NsG-360; Contract DA-28-043-AMC-00099(E))
(NASA-CR-81567) CFSTI: HC$3.00/MF$0.65 CSCL 20H

Data are presented to support the theory that low energy ion–atom and ion–molecule collisions are effective in producing optical excitations. In the example given, the excitation function is depicted for a He–I multiplet at 3888 Å originating from the 3^3P levels, when helium gas is bombarded with helium ions. The laboratory energy ranged from ≈20 eV to ≈5 keV. It is shown that the cross section does not decrease monotonically at energies below several kilovolts; in fact, in many cases the cross section attains a large fraction of its maximum value within a few electron volts of threshold. It is also noted that the apparent thresholds for the various levels occur at somewhat higher energies than those required by simple energy conservation. This is considered to indicate that the relevent pseudo-crossing between the molecular levels occurs above the energy corresponding to the final state of the isolated atoms. M.G.J.

N68-27538*# Pittsburgh Univ., Pa. Dept. of Physics.

CLASSICAL APPROXIMATION FOR IONIZATION BY HEAVY PARTICLE IMPACT

J. D. Garcia, E. Gerjuoy, and Jean E. Walker (NASA. Goddard Space Flight Center) [1966] 3 p Presented at the 5th Intern. Conf. on The Phys. of Electron. and Atomic Collisions, Leningrad, 17–23 Jul. 1967
(Grant NGR-39-011-035)
(NASA-CR-81435) CFSTI: HC$3.00/MF$0.65 CSCL 20H

An assessment is made of a classical binary approximation method which is based on a knowledge of the differential cross section for the exchange of energy in the lab *frame* between two charged particles of unequal mass, averaged over all velocity orientations of one particle. An expression is derived for the ionization cross section for proton impinging upon an atom; the resultant cross section is then to be averaged over the velocity distribution of the bound electrons. Specific contributions to the method are described as (1) the use of the exact expressions for the differential cross section, avoiding any approximation, and (2) the use of the quantum mechanically-correct velocity distribution for the bound electron in the case of ionization of hydrogen by proton impact. Author

N68-27539# Australian National Univ., Canberra. Research School of Physical Sciences.

TENSOR POLARIZATION OF DEUTERONS FROM ^{12}C-d ELASTIC SCATTERING

H. Corda, G. U. Din, M. Ivanovich, and B. A. Robson [1968] 16 p refs

(ANU-P/406) CFSTI: HC$3.00/MF$0.65

The spin tensor moments $\langle T_{20} \rangle$, $\langle T_{21} \rangle$ and $\langle T_{22} \rangle$ of deuterons from ^{12}C-d elastic scattering have been measured utilizing the ^{3}He(d,p)^{4}He reaction as an analyzer of deuteron polarization. The three deuteron polarization parameters are presented as functions of incident deuteron energy between 3.5 and 7.1 MeV at 37.5° and 45° scattering lab angles. The tensor moments are also presented as functions of scattering angle between 22.5° and 75° lab angles in steps of 7.5° at 5.25, 6.10 and 7.05 MeV deuteron incident energies. An optical model analysis which included tensor terms in the deuteron potential has been performed. Author

N68-27540# Australian National Univ., Canberra. Dept. of Nuclear Physics.

SPECTROSCOPIC FACTORS FROM ^{208}Pb(d,p)^{209}Pb AT 8.00 MeV

G. M. Crawley, B. V. Narasimha Rao, and D. L. Powell [1968] 19 p refs

(ANU-P/401) CFSTI: HC$3.00/MF$0.65

The reaction of ^{208}Pb(d,p)^{209}Pb has been studied in the region below the Coulomb barrier in order to investigate the accuracy with which spectroscopic factors can be obtained from this process. Both distorted wave and analytic calculations are discussed. The dependence of the spectroscopic factors on the geometry of the bound state well leads to a value of 6.06 fm. for the root mean square radius of the nuclear potential. This is larger than the value obtained from electron scattering measurements. Author

N68-27546# Australian National Univ., Canberra. Research School of Physical Sciences.

BRANCHING RATIOS OF Al 27 BOUND STATES

R. V. Elliott, T. R. Ophel, and R. H. Spear [1968] 16 p refs

(ANU-P/408) CFSTI: $3.00

A 12.7 cm × 10.2 cm NaI(Tl) gamma-ray spectrometer has been used in conjunction with a 61-cm magnetic particle spectrometer to measure gamma-ray branching ratios for bound state of ^{27}Al at excitation energies of 2.21, 2.73, 2.98, 3.00, 3.68, 3.98, 4.05, 4.41, 4.51, and 4.58 MeV. Author

N68-27561*# Oak Ridge National Lab., Tenn. Neutron Physics Div.

HIGH ENERGY NUCLEON TRANSPORT

R. G. Alsmiller, Jr. 6 Jun. 1967 30 p refs Presented at the Ann. Meeting of the Am. Nucl. Soc., San Diego, Calif., 11–15 Jun. 1967

(NASA Order R-104(1))

(NASA-CR-85623; ORNL-TM-1839) CFSTI: HC $3.00/MF $0.65 CSCL 20H

In this paper the recent work on the transport of high-energy nucleons through dense matter is reviewed. The application of this transport to space-shielding studies is emphasized so the discussion is restricted to low and intermediate energies (≤ 1 GeV) and to relatively thin shields. Author

N68-27607*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

POLARIZATION IN He^{3} He^{4} SCATTERING NEAR 26 MeV

E. T. Boschitz and J. S. Vincent [1967] 12 p refs Presented at the Intern. Conf. on Nucl. Phys., Gatlinburg, Tenn., 12–17 Sep. 1966

(NASA-TM-X-59045) CFSTI: HC$3.00/MF$0.65 CSCL 20H

Using the classical double scattering technique in which center of mass energies and angles are matched (A = P2), we have measured the polarization of He^{3} scattered by He^{4} at θ_{cm} = 130° near E_{LAB} = 26 MeV. The observed asymmetry was A = 0.190 ± 0.030 which yields $|P|$ = 0.436 ± 0.054, indicating the usefulness of the He^{3}–He^{4} scattering as a source of 26 MeV polarized He^{3} particles. Author

N68-27608# Australian National Univ., Canberra. Research School of Physical Sciences.

OPTICAL MODEL AMBIGUITIES FOR ^{22}Ne (^{3}He, ^{3}He) ^{22}Ne ELASTIC SCATTERING AT 10 MeV

K. H. Bray, J. Nurzynski, and W. P. Bourke [1967] 21 p refs

(ANU-P/405) CFSTI: HC$3.00/MF$0.65

The angular distribution for the elastic scattering of 9.744 MeV ^{3}He particles by ^{22}Ne nuclei has been measured from 15° to 160° (lab.). An optical model analysis, using a central, Woods–Saxon poetntial with volume absorption has indicated a continuous optical potential ambiguity, which appears to be due to the strong dependence of the scattering on the nuclear surface. Author

N68-27609# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.

THE SEMINAR AT THE PHYSICS LABORATORY DURING THE PERIOD SEPTEMBER–DECEMBER, 1967 [IL SEMINARIO DEI LABORATORI DI FISICA NEL QUADRIMESTRE SETTEMBRE–DICEMBRE 1967]

3 Jan. 1968 59 p refs In ITALIAN; ENGLISH summary

(ISS-68/1) CFSTI: HC$3.00/MF$0.65

In the lecture series reported, attention in the area of biophysics centered on food irradiation research in Germany, biosynthesis of RNA in *E. coli*, structure and synthesis of RNA in higher cells, and DNA mitochondria and mutations in the cytoplasm of yeast. In the nuclear physics field, subject matter pertained to coherence and photon counting, atomic absorption of photons between 20 and 1000 eV, electro-optics and magneto-optics effects on solids, measurements of cross sections and polarization in 185 MeV proton scattering, instrumentation for elementary particle production and decay, and Mark 2 linear accelerator experiments. A synopsis of each lecture is presented. Transl. by F.S.

N68-27614*# California Univ., Riverside. Physics Dept.

MODIFIED OPTICAL-POTENTIAL APPROACH TO LOW-ENERGY ELECTRON-NEON SCATTERING

E. S. Chang, R. T. Pu, and W. M. Duxler [1967] 15 p refs Presented at the 5th Intern. Conf. on the Phys. of Electron. and Atomic Collisions, Leningrad

(Grant NGR-05-008-005)

(NASA-CR-85630) CFSTI: HC$3.00/MF$0.65 CSCL 20H

The modified optical potential approach, successfully applied to electron-helium elastic scattering, is extended to the problem of electron-neon scattering. Qualitative agreement with experiments in the energy range from 0.5 to 8.7 eV is obtained, using just the direct part of the dipole second order potential. This calculation improves over the static exchange approximation by accounting for the polarization of the atom and by not invoking the adiabatic approximation. Author

N68-27686*# Maryland Univ., College Park.

ION MOTION IN ELECTROSTATIC DIPOLE FIELDS

Thyagaraja Chandrasekharan Apr. 1968 94 p refs
(Grants NsG-283; NIGMS-13486)
(NASA-CR-95186; BN-545) CFSTI: HC $3.00/MF $0.65 CSCL 20H

An analytic approach to the complex problem of the classical unbound motion of an ion in the field of a fixed point electrostatic dipole is developed. With the formalism, it has been shown that the entire trajectory of the ion can be traced. An important constant of motion has been identified, and it has also been shown that by suitable translation of the origin of time a symmetric quadratic expression in time can be obtained. Investigation of motion in the meridian plane indicates that the general meridian plane orbit can be defined in terms of three parameters (the asymptotic polar angle, energy, and the impact parameter), and that the orbits in general cannot be reflected about apsidal vectors. It has also been shown that there are two types of turning points, the radial and the angular, for the dipole problem. The general case of nonplanar motion has been solved and an expression in terms of functions which are types of incomplete elliptic integrals of the third kind have been obtained. A.L.

N68-27688# Australian National Univ., Canberra. Dept. of Nuclear Physics.

PROTON PROTON BREMSSTRAHLUNG AT 10.5 MEV

G. M. Crawley, D. L. Powell, and B. V. Narasimha Rao [1968] 8 p refs
(ANU-P/407) CFSTI: HC$3.00/MF$0.65

The proton proton bremsstrahlung cross section was measured at an incident proton energy of 10.5 MeV. The upper limit of 1.3 $\mu b/st^2$ helps to distinguish between the various calculations at this energy. Author

N68-27699# Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica.

INTRODUCTION TO RADIATION PHYSICS, CHAPTER 7 [INTRODUZIONE ALLA FISICA DELLE RADIAZIONI, CAPITOLO 7]

U. Amaldi, Jr. 21 Feb. 1968 76 p ref In ITALIAN; ENGLISH summary
(ISS-68/6, Ch. 7) CFSTI: HC$3.00/MF$0.65

This is the seventh of the series of reports on the lectures on Radiation Physics held at the "Scuola di Specializzazione in Radiologia Medica dell'Università di Roma". This issue is devoted to the description of radiation sources, and in particular to radioactive sources, X-ray units and betatrons. In the last section other particle accelerators of radiological use are briefly described. Author

N68-27740 Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).

NEUTRON-PROTON SURFACE DELTA INTERACTION IN SPHERICAL ODD MASS NUCLEI

E. Reya and H. Baier 1968 10 p refs Submitted for publication
(SGAE-PH-64/1968) CFSTI: $3.00

Assuming an n-p surface delta residual interaction (SDI) we develop a theory for calculating various physical quantities of spherical odd mass nuclei. Formulas are based on the quasiparticle Tamm Dancoff approximation. Author

N68-27771# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE QUESTION ABOUT DETERMINATION OF EFFECTIVE RATE OF DISSOCIATION OF DIATOMIC MOLECULES [K VOPROSY OB OPREDELENII DEYSTVITEL'NOY KONSTANTY SKOROSTI DISSOTSIATSII DVUKHATOMNYKH MOLEKUL]

L. A. Lednova *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 182–189 refs (See N68-27756 16-23)

A short review is given on the methods for determination of the effective rate of dissociation for diatomic molecules. The results of the calculation carried out by these methods are given. Author

N68-27781 Wisconsin Univ., Madison.

TWO APPLICATIONS OF PERTURBATION THEORY IN MOLECULAR QUANTUM MECHANICS

Tai Yup Chang (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-4939

The moderately long-range interaction energies of degenerate atoms for non-resonant cases have been studied throughout the moderately long-range region. Extensive tabulation of necessary parameters and atomic properties for the calculation of the first-order quadrupole-quadrupole interaction energies has been made. The estimated van der Waals dispersion energies for the first-row atoms are shown to be of almost the same size as the quadrupole-quadrupole interaction energies at the separation of twice the sum of the atomic radii. A perturbation theory of heteronuclear diatomic molecules based on the isoelectronic homonuclear molecules is developed for calculating the molecular energy, equilibrium internuclear distance, dissociation energy, and electric dipole moment. Dissert. Abstr.

N68-27806*# Pittsburgh Univ., Pa. Dept. of Physics.

CLASSICAL CALCULATIONS OF CHARGE TRANSFER CROSS SECTIONS

J. D. Garcia, E. Gerjuoy, and Jean E. Welker (NASA. Goddard Space Flight Center) [1967] 5 p refs Presented at the 5th Intern. Conf. on the Phys. of Electron. and Atomic Collisions, Leningrad, 17–23 Jul. 1967 Sponsored in part by ARPA
(Grant NGR-39-011-035)
(NASA-CR-81433) CFSTI: HC$3.00/MF$0.65 CSCL 20 H

Gryzinski's classical procedures for estimating charge transfer cross sections are critically examined, and an exact formula for the cross section is proposed for the approximate expression which was suggested in the original equation. It is felt that use of the exact formula eliminates uncertainties concerning the effects of approximating the cross section, thereby permitting a less ambiguous evaluation of the utility of Gryzinski's procedures. It is also pointed out that the exact formula can be integrated in closed form. Various possibilities for extending the original energy transfer range are also examined in relation to the ionization potentials of the transferring electron in its initial and final bound orbits. Consideration is also given to calculations for an incident simply charged ion, and to experiments for protons incident on the noble gases and for protons incident on the alkali atoms. A.L.

N68-27818 Michigan Univ., Ann Arbor.

MESONS AND SPECTATOR PROTONS IN $\pi^+d\to\pi^+\pi^-\pi^0$ pp AT 3.65 BeV/c

George Carl Benson (Ph.D. Thesis) 1966 255 p
Available from Univ. Microfilms: HC $11.50/MF $3.30 Order No. 67-8214

There were 250,000 pictures taken in the 20-in. Brookhaven National Laboratory deuterium bubble chamber. The chamber was exposed to 3.65 BeV/c π^+ mesons. The following π^+d cross sections were determined for the final states (in mb): (m π^0)pp, m≥1 (1.95±0.19); $\pi^+\pi^-$pp (2.58±0.21); $\pi^+\pi^-\pi^0$pp (3.44±0.31); and $\pi^+\pi^-$ (mπ^0)pp, m≥2 (2.88±0.35). The $\pi^+\pi^-\pi^0$pp state which is studied here consists of 2993 events. Dissert. Abstr.

N68-27826 California Univ., Davis.

THE CALCULATION OF SEPARATED-PAIR WAVE FUNCTIONS FOR SOME ATOMIC SYSTEMS

Ulrich Otto de la Camp (Ph.D. Thesis) 1966 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8867

Accurate wavefunctions have been calculated for the three atomic four-electron systems Li−, Be and B+, using the separated-electron-pair formalism. The starting point for the build-up of each pair function was an SCF function that had been calculated by the Roothaan matrix expansion technique. Correlation effects have been accounted for by the introduction of further s-, p- and d-orbitals. The percentages of correlation energy that are accounted for are 75.8%, 87.7% and 93.4% respectively. The wavefunction for Be gives an energy nearly as good as the best configuration interaction function, using orthogonal orbitals, that is available. The concept of such localized orbitals is shown to be of limited utility in the four-electron systems where the canonical SCF orbitals are already strongly localized into 1s and 2s shells. A much less accurate wavefunction was calculated for the 1S state of the six-electron system B−. Only s- and p-orbitals, were admitted into the three pairs and the starting point was again an SCF function.
Dissert. Abstr.

N68-27836 Minnesota Univ., Minneapolis.

A STUDY OF CROSS SECTION FLUCTUATIONS FOR Li^6 BOMBARDMENT OF C^{12}

Thomas Gary Dzubay (Ph.D. Thesis) 1966 68 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-7719

Differential cross sections for Li^6 + C^{12} reactions were measured in 100 keV steps between 2.4 and 8.5 MeV at 0° and in 200 keV steps between 3.4 and 7.4 MeV at 40° (LAB). Fluctuations in the cross sections are observed at all energies, but they are superimposed upon a rapid rise in cross section for beam energies below 5 MeV due to the Coulomb barrier effects. Coulomb barrier effects are accounted for by calculating the average differential cross section from the Hauser-Feshbach formula in which the transmission coefficients are calculated from an optical model potential. The ratios of the observed to calculated cross sections fluctuate about an average that is nearly constant. These ratios are analyzed in terms of the Ericson fluctuation theory from which the coherence width Γ and the direct reaction contribution Y_d are estimated to be Γ = 220 keV (CM) and Y_d = 0 to 50%. The average cross section ratio for the Li^6(C^{12}, α_1)N^{14} reaction indicates a 30% violation of isobaric spin conservation.
Dissert. Abstr.

N68-27837 Pennsylvania Univ., Philadelphia.

EVEN PARITY ROTATIONAL BANDS IN O^{16}

Louis Silvio Celenza (Ph.D. Thesis) 1966 125 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7828

Experimental information regarding the positions of energy levels and the transition rates between certain of these levels has led one to believe that rotational motion may be important in the microscopic description of O^{16}. In particular the low-lying even parity levels of O^{16} may be qualitatively described as consisting of two even parity rotational bands which are allowed to interact with one another. No detailed microscopic calculation has as yet verified this qualitative description. This thesis provides such a calculation. The method of calculation consists of two parts. In the first part variational techniques are employed to find the intrinsic wave functions which generate the two even parity bands. This procedure allows the intrinsic wave function of the second even parity band to be isolated in energy from other competing wave functions. The second part of the calculation includes a projection of states of good angular momentum from the intrinsic wave functions. The bulk of the results consists of the prediction of the positions of various low-lying even parity levels in O^{16} and the transition rates between certain of these levels. Dissert. Abstr.

N68-27838 Cornell Univ., Ithaca, N. Y.

A GAUGE THEORY OF STRONG INTERACTIONS WITH AN APPLICATION TO THE VECTOR MESON SYSTEM

David John Brown (Ph.D. Thesis) 1966 74 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-1449

The consequences of requiring a Lagrangian density to be invariant under the transformations of a Lie group with coordinate dependent parameters (Gauge groups) was investigated. An interaction Lagrangian for the vector mesons that is a consequence of the Gauge theory was investigated. Using this Lagrangian the sign and magnitude of the usual Born exchange terms modified by the point interaction term were calculated. This point interaction was shown to be equivalent to subtractions in the Mandelstam amplitudes. In particular the conclusion was reached that the concept of the vector meson nonet as being formed solely from the pseudoscalar mesons must now be doubted. It seems that the vector mesons must be considered also as bound states of themselves.
Dissert. Abstr.

N68-27839 Michigan Univ., Ann Arbor.

PION NUCLEON ELASTIC SCATTERING IN THE BACKWARD HEMISPHERE AND THE APPLICATION OF REGGE THEORY TO BACKWARD ANGLES OTHER THAN COS θ^* = −1

Fikri Ned Dikmen (Ph.D. Thesis) 1966 79 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-8242

The differential cross-sections for elastic scattering of pions by protons for laboratory pion momenta between 2.3 and 6.0 Bev/c have been measured in a spark chamber experiment at the Argonne Z.G.S. Regge Pole theory is applied to the differential cross-sections for backward angles in the center of mass for the reaction $\pi^- p \to \pi^- p$. The fits obtained from this theory qualitatively disagree with the data. A model is suggested based on pure resonances only, to fit the backward hemisphere. Dissert. Abstr.

N68-27844 Rutgers Univ., New Brunswick, N. J.

AXIAL DIFFUSION AND PROBE PERTURBATION IN A HYDROGEN-ATOM FLOW-SYSTEM

Philip Benjamin Rudnick (Ph.D. Thesis) 1967 97 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-9262

The study of the overall rate of a reaction, Reactant → Products, involves fitting the observed time-rate of disappearance to a rate law. The commonest method for the kinetic study of atom recombination is the flow system, using a catalytic probe as an atom detector. Direct experimental measurements were therefore made to determine (a) the relative contributions of convective and diffusive flow and (b) the extent, if any, of probe perturbation. To study probe effect, a series of platinum detectors of different surface areas with a wide range of calibrated efficiencies was used. Since in the limit of an infinitely small probe there is no perturbation, a comparison of results with those obtained using larger probes indicated the extent of probe perturbation. Dissert. Abstr.

N68-27914*# Stanford Research Inst., Menlo Park, Calif.

POTENTIALS FOR He$^+$ + Ar AND He$^+$ + Ne DEDUCED FROM ELASTIC SCATTERING DATA

Felix T. Smith [1967] 3 p refs Presented at the 5th Intern. Conf., Leningrad, 17 Jul. 1967
(Contract NASr-49(07))
(NASA-CR-85719) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Two sets of data were replotted together for the elastic scattering of He+ on Ne and Ar: the results in the energy range 10 to 600 eV, and in the range 25 to 100 keV. In the latter case, the total pseudoelastic cross section was used (irrespective of the final charge state or excitation level of the He) as best representing the deflection of the projectile He++ as it passes through the field of the scatterer. The data showed great internal consistency, providing empirical confirmation of the scaling law and allowing the potential to be deduced. Simple exponential forms are given to express the effects of shell structure prominent in the screening

Screen lengths deduced from these data are compared with predictions of a simple hydrogenic model in which they are related to the closed shell ionization potentials. An equation is derived for fitting the deviation from the simple repulsive curve and the rainbow angle, using a polarization term with screening as the outermost shell of the target is penetrated. Estimates of the polarizability are given and compared with calculated values. M.G.J.

N68-27952# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

EQUILIBRIUM DEFORMATIONS OF THE GROUND AND EXCITED STATES OF STRONGLY DEFORMED NUCLEI

D. A. Arseniev, L. A. Malov, V. V. Pashkevich, and V. G. Soloviev 1968 31 p refs Submitted for publication

(JINR-E4-3703)

The equilibrium deformations for nuclei were calculated and the dependence of the energy on the deformation parameters β and γ was studied. It is shown that for strongly deformed nuclei, the total energy has two minima depending on β for $\gamma = 0$: at $\beta_0 = 0.2$ to 0.3 (with the energy 4 to 8 MeV with respect to the nuclear energy, at $\beta = 0$) and at $\beta_0 = 0.1$ to 0.2 (with the energy 1.5 to 5 MeV). While studying the behavior of the total energy $E(\beta,\gamma)$ as a function of the parameters β and γ, it was found that this function has only one minimum at $\gamma = 0$ and $\beta \approx 0.2$ to 0.3. Investigation of the equilibrium deformations of the excited states have shown that there exist no excited states with the equilibrium deformation $\beta_e < 0$ while for the ground state $\beta_0 > 0$. The conclusions mentioned refer to the deformed nuclei, far from the transition region. For the nuclei of the transition region, the deformation of the excited states may differ considerably on β as well as on γ from that of the ground state. Author (NSA)

N68-27953# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.

MEASUREMENTS OF THE PROBABILITY OF HEAVY CHARGED PARTICLE EMISSION IN NEGATIVE MUON CAPTURE BY NEON NUCLEI [IZMERENIE VEROYATNOSTI ISPUSKANIYA TYAZHELYKH ZARYAZHENNYKH CHASTITS PRI ZAKHVATE μ-MEZONOV YADRAMI NEONA]

V. I. Komarov and O. V. Savchenko 1968 8 p refs In RUSSIAN

(JINR-P1-3721)

The probability W of heavy charged particle emission per event of nuclear muon capture in neon was measured by the isotropic discharge chamber method. The value $W = 0.20 \pm 0.04$ obtained by the detection of particles having a range larger than 4.2 mg cm^{-2} Ne points out the essential contribution of 1- to 5-MeV protons to the energy spectrum of emitted particles. Author (NSA)

N68-27954# Joint Inst. for Nuclear Research, Dubna (USSR).

POLARIZATION EXPERIMENTS ON THE T-INVARIANCE AND CPT-INVARIANCE TEST IN NUCLEON–NUCLEON AND NUCLEON–ANTINUCLEON SCATTERING [POLYARIZATSIONNYE OPYTY PO PROVERKE T- I CPT-INVARIANTNOSTI V NUKLON-NUKLONNOM I NUKLON-ANTINUKLONNOM RASSEYANII]

S. M. Bilen'kii, L. I. Lapidus, and R. M. Ryndin 1968 20 p refs In RUSSIAN

(JINR-P2-3716)

The experiments of the T-invariance test in elastic N–N scattering are discussed. The results of the experiments performed are given. The possible experiments on the CPT-invariance test in elastic proton–antiproton scattering are also considered. Author (NSA)

N68-27955# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.

MASS DISTRIBUTION OF THE FISSION FRAGMENTS OF THE BISMUTH AND URANIUM NUCLEI BY HEAVY IONS [MASSOVOE RASPREDELENIE OSKOLKOV DELENIYA YADER VISMUTA I URANA TYAZHELYMI IONAMI]

S. A. Karamyan, F. Normuratov, Yu. Ts. Oganesyan, Yu. E. Peniozhkevich, B. I. Pustyl'nik et al 1968 14 p refs In RUSSIAN Submitted for publication

(JINR-P7-3732)

Mass distributions of the fission fragments were measured in the reactions ^{238}U(^{20}Ne,f), ^{238}U(^{40}Ar,f), and ^{209}Bi(^{20}Ne,f). The isotopes produced in these reactions were identified by the γ-spectroscopic method using a Ge(Li) γ spectrometer. It is shown that the mass distribution widens with the increase of the excitation energy and the Z^2/A of the fissioning nucleus. The width parameter σ^2 of the mass distribution increases more sharply with the increase of the excitation energy than by $\sigma^2 \approx T$. The constant C of charge distribution also increases but more weakly than σ^2. Author (NSA)

N68-27956# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

E MESON AND MESON–BARYON SCATTERING IN THE BROKEN SU$_w$ (6) SYMMETRY [E MEZON I MEZON–BARIONNOE RASSEYANIE V NARUSHENNOI SU$_w$ (6)-SIMMETRII]

A. N. Zaslavskii and V. Tybor 1968 13 p refs In RUSSIAN Submitted for publication

(JINR-P2-3758)

The consequences of the SU$_w$(6) violation in the meson–baryon collision amplitudes are investigated. The obtained ratios between the process cross sections do not contradict the available experimental data. The broken SU$_w$(6) symmetry allows one to conclude that ninth pseudoscalar E(1420)-meson is to be produced as often as the η-meson. Author (NSA)

N68-27957# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.

STUDY OF IRON IONS IN ^{57}Fe-DOPED AgCl USING THE MOESSBAUER EFFECT [ISSLEDOVANIE SOSTOYANIYA IONOV ZHELEZA V AGCL, DOPIROVANNOM ^{57}FE, S POMOSHCH'YU EFFEKTA MESSBAUERA]

K. Hennig 1968 5 p refs In RUSSIAN Submitted for publication

(JINR-P14-3776)

The Mössbauer effect in AgCl doped with ^{57}Fe confirms one of the interpretations of the velocity spectrum obtained earlier in AgCl doped with ^{57}Co, according to which the divalent substitutionally placed iron is associated with a cation vacancy. Author (NSA)

N68-27958# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

ON THE CALCULATION OF THE COUPLING CONSTANTS OF THE ATOMS IN METAL ADMIXTURES [O RASCHETE KONSTANT SVYAZI ATOMOV PRIMESEI V METALLAX]

V. B. Priezzhev 1968 16 p refs In RUSSIAN Submitted for publication

(JINR-P4-3746)

Strength constants in the Cu lattice with the Be admixtures are investigated. Changes of the strength constants in the zero and first coordination sphere are determined. An explicit separation of the contributions to the strength constants of short- and long-range forces is made and their changes are measured when introducing the admixtures. Author (NSA)

N68-27959# Joint Inst. for Nuclear Research, Dubna (USSR). Lab of Nuclear Problems.

THE ^{156}Gd LEVELS EXCITED BY THE DECAY OF ^{156}Tb [UROVNI ^{156}Gd, VOZBUZHDAYUSHCHIESYA PRI RASPADE ^{156}Tb]

P. Galan, V. V. Kuznetsov, M. Ya. Kuznetsova, O. B. Nielsen, J. Urbanec et al 1968 106 p refs In RUSSIAN Submitted for publication

(JINR-P6-3695)

The conversion electron spectra, γ-ray spectra, and e-γ and γ-γ coincidence spectra from the decay of ^{155}Tb were investigated. The decay scheme, ^{155}Tb → ^{155}Gd is suggested. The e-γ and γ-γ coincidence experiments prove the existence of the 60.0, 86.5, 105.3, 118.0, 235.2, 266.6, 268.8, 286.8, 326.0, 367.7, 427.4, 451.3, 488.6, and 647.8 keV levels in the ^{155}Gd nucleus. The scheme of the ^{155}Gd levels is considered from the point of view of generalized and superfluid models. The levels with the energies 592.6 keV (3/2 −) and 647.8 keV (5/2−) are considered to be the states of the rotational band of β-vibrational state $[521]\uparrow\beta$, while the levels with the energies 559.9 keV (1/2 −) and 615.5 keV (3/2−) are considered to be the terms of the rotational band of mixed stage $[521]\downarrow$ with the γ-vibrational state $[521]\uparrow$ $(\gamma K = K_0^{-2})$. Author (NSA)

N68-27960# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

SYMMETRIES AND THEIR VIOLATIONS IN THE AXIOMATICS OF QUANTUM FIELD THEORY [SIMMETRII I IKH NARUSHENIYA V AKSIOMATIKE KVANTOVOI TEORII POLYA]

A. N. Vasil'ev 1967 40 p refs In RUSSIAN; ENGLISH summary Presented at the Conf. on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, May 1967
(ITF-67-32; CONF-670544-7)

A rigorous statement of the problem of symmetry and its violations are considered in the framework of Wightman's axiomatics. Author

N68-27961# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

PROBLEM OF DRESSING THE OPERATORS IN AXIOMATIC QUANTUM FIELD THEORY [PROBLEMA ODEVANIYA OPERATOROV V AKSIOMATICHESKOI KVANTOVOI TEORII POLYA]

A. D. Sukhanov 1967 29 p refs In RUSSIAN; ENGLISH summary
(ITF-67-41)

The problem of "dressing" various quantities under the action of the model β-matrix, corresponding to the counter term of the field renormalization, in the framework of axiomatic method is considered. The charge is conserved but the argument-function varies, that is, the field ϕ is changed to the field A_R, belonging to a nonequivalent representation of canonical commutation relations. The S-matrix, Heisenberg operators, various nonlinear relations as well as current-like operators Λ_n are "dressed". Author (NSA)

N68-27963# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

HAMILTONIAN FORMALISM IN RENORMALIZED QUANTUM ELECTRODYNAMICS [GAMIL'TONOV FORMALIZM V PERENOPMIROVANNOI KVANTOVOI ELEKTRODINAMIKE]

S. V. Svechnikov 1967 15 p refs In RUSSIAN; ENGLISH summary
(ITF-67-43)

The method developed previously is applied to quantum electrodynamics. A modified Hamiltonian formalism provides an effective instrument for obtaining the commutators of currents. A more correct version of the mathematical formalism developed by B. V. Medvedev and M. K. Polivanov in the "pure renormalization" model is considered. Author (NSA)

N68-27964# Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies.

DYNAMICS OF STRONG INTERACTIONS

R. Omnes Oct. 1967 19 p Presented at the Intern. Conf. on Elementary Particles, Heidelberg
(LPTHE-TH-222; CONF-670934-11)

A review of topics on the dynamics of strong interactions is given. This review includes perturbation calculations, the analytic S-matrix, a bound on the $\pi^0\pi^0$ scattering length, Reggeization near t=0, and bootstrap. Also discussed are finite-energy sum rules, rising trajectories, the bootstrap of rising trajectories, Gribov–Pomeranchuk poles, and cuts. NSA

N68-27965# Gulf General Atomic, San Diego, Calif.

DECAY OF A NEUTRON PULSE IN A FAST NONMULTIPLYING SYSTEM AS AN INTEGRAL CHECK ON THE HIGH ENERGY INELASTIC SCATTERING

Tsahi Gozani and P. D'Oultremont 13 Feb. 1968 15 p refs Presented at the 2d Conf. on Neutron Cross Sect. and Technol., Washington, D. C.
(Contract AT(04-3)-167)
(GA-8536; CONF-680307-30) CFSTI: HC$3.00/MF$0.65

The early time behavior of the neutron population in a pulsed sphere of highly depleted uranium (50.8 cm dia) was measured with ^{237}Np solid-state threshold fission detector. The decay, measured with one nsec time resolution, showed an apparent exponential behavior over a relatively large time range. The measured decay was by no means asymptotic, as demonstrated by the fact that the decay constant was $5.9 \pm 0.2 \times 10^7$ sec^{-1} at R=11.7 cm, and $4.62 \pm 0.15 \times 10^7$ sec^{-1} at R=17.8 cm. Furthermore, the decay at times longer than 100 nsec loses its exponential feature. A simple multi-group Monte Carlo code, BN-MOC, was used to compute the time response of the detector. Fairly good agreement with the measurement was obtained by using the measured target source, highly anisotropic scattering and the ENDF/B cross sections for ^{238}U. Additional calculations demonstrated the large sensitivity of the decay to variations in the inelastic scattering cross section of ^{238}U. Similar variations had a smaller effect on the steady state spectrum. The experimental and calculational results have shown the feasibility of using these techniques as a sensitive integral check on inelastic scattering in the low MeV energy range. Author (NSA)

N68-27967# Gulf General Atomic, San Diego, Calif.

CROSS SECTION MEASUREMENTS OF ZIRCONIUM

W. M. Lopez 28 Feb. 1968 12 p refs Presented at the 2d Conf. on Neutron Cross Sect. and Technol., Washington, D. C.
(Contract AT(04-3-167)
(GA-8557; CONF-680307-31) CFSTI: HC$3.00/MF$0.65

Time-of-flight capture, self-indication, and transmission measurements of natural zirconium samples and samples enriched in ^{91}Zr (91%) were made at the Gulf General Atomic linear accelerator facility. Parameters were obtained for resonances in ^{91}Zr in the neutron energy range below 4 keV. The radiation width, Γ_γ=0.12±0.03 eV, obtained in this work for the 292- and 681-eV resonances is considerably smaller than previously reported values obtained from transmission measurements. The value of Γ_γ is, however, consistent with previous values deduced from low-resolution capture measurements. Low-energy (0.01 to 1 eV) capture cross sections for natural zirconium and a table of resonance parameters for ^{91}Zr are presented. Author (NSA)

N68-27969# Brookhaven National Lab., Upton, N. Y.

BEAM DEFLECTING ELEMENTS AND THEIR EFFECT ON CLOSED ORBITS IN THE AGS. METHOD OF CALCULATION WITH ILLUSTRATIVE EXAMPLES

U. Vogel [1967] 27 p refs
(BNL-12375) CFSTI: HC$3.00/MF$0.65

A procedure for calculating closed orbits in the AGS is presented. The calculations take into account the beam deflecting elements which are used to correct for perturbations in the ring fields and to control or steer the proton beam onto internal targets and exit slits. NSA

N68-27976# Paris Univ., Orsay (France). Inst. of Nuclear Physics.

GENERALIZED SENIORITY BREAKING OF TWO BODY INTERACTIONS

O. Bohigas, C. Quesne, and R. Arvieu Feb. 1968 15 p refs
(IPNO/TH-121)

An expansion of the two-body potential in three parts which participate differently in the breaking of the generalized seniority is derived. The magnitude of each term is calculated for most of the interactions used recently in shell model calculations. The term which has only diagonal elements in the generalized seniority scheme is found to be by far the largest. (NSA)

N68-27977# Paris Univ., Orsay (France). Linear Accelerator Lab.
POSITIVE PION PHOTOPRODUCTION FROM HYDROGEN FOR INCIDENT PHOTON ENERGIES 300–750 MEV
C. Betourne, J. C. Bizot, J. Perez-Y-Jorba, D. Treille, and W. Schmidt (Stanford Univ.) Feb. 1968 47 p refs
(LAL-1186)

The differential cross section for the reaction $\gamma + p \rightarrow \pi^+ + n$ was measured at 19 photon energies, between 300 and 750 MeV in the laboratory, for pion angles between 0 and 130° in the cms system. The pions were analyzed in angle and momentum with a magnetic spectrometer and detected by a counter telescope. The 0° measurements could be achieved, in spite of the excessive positron rate, owing to a mass spectrometer arrangement. No direct indication for the electromagnetic excitation of the P_{11}-resonance (1466 MeV) was found. Comparison is made with theoretical calculations of π^+ photoproduction. Author (NSA)

N68-27979# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
SCATTERING MATRIX OF THE QUANTUM CHARGED FIELD BY THE ELECTROMAGNETIC PLANE WAVE [MATRITSA RASSEYANIYA KVANTOVOGO ZARYAZHENNOGO POLYA POLEM PLOSKOI ELEKTROMAGNITNOI VOLNY]
B. M. Barbashov and V. N. Pervushin 1968 10 p refs In RUSSIAN Submitted for publication
(JINR-P2-3753)

An exact value of the S-matrix, determining the scattering of the quantum charged particles by the electromagnetic plane wave field, was found. It is shown that the polarization effects of vacuum lead to nonessential phase factor in the S-matrix. The obtained S-matrix leads only to elastic forward scattering of particles. Author (NSA)

N68-27980# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
REACTIONS WITH TRANSFER OF TWO PARTICLES
I. Rotter 1968 13 p refs Submitted for publication
(JINR-E4-3742)

A formula is given for the spectroscopic factor determining the excitation of any level of the final nuclei in reactions between complex nuclei. All intermediate states which are formed by the transferred nucleons and which are compatible with the quantum numbers of the nuclei are taken into account. The reactions $(^{6}\mathrm{Li},\alpha)$ and $(^{18}\mathrm{F},^{16}\mathrm{O})$ on light nuclei are considered in more detail. Author (NSA)

N68-27981# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
ELASTIC SCATTERING OF 600 MEV PROTONS ON LMN CRYSTALS
Ya. Chekh, Z. Yanout, F. Legar, and Z. Malek 1969 21 p refs Submitted for publication
(JINR-E1-3706)

Elastic and quasielastic 660 MeV proton scattering on various targets was investigated. Crystal LMN ($La_2Mg_3(NO_3)_{12} \times 24\ H_2O$), the equivalent dummy target consisting of $Ba(NO_3)_2$ (36.37%) and MgO (63.63%) and polythene were used as targets. The results can be used for the planning of the nucleon-nucleon scattering experiments on a proton polarized target. Author (NSA)

N68-27985# California Univ., Berkeley. Lawrence Radiation Lab.
STUDIES ON ELECTRONICALLY EXCITED METASTABLE STATES OF MOLECULES WITH AN ULTRAHIGH-VACUUM MOLECULAR BEAM APPARATUS
R. Clampitt and Amos S. Newton Dec. 1967 53 p refs
(Contract W-7405-ENG-48)
(UCRL-18032) CFSTI: HC$3.00/MF$0.65

A molecular-beam apparatus designed for studies on metastable excited states of molecules is described. A molecular beam is crossed by an electron beam to produce electronically excited molecules. These pass into a chamber, operating at ultrahigh vacuum, and are detected by electron ejection from the surface of a photosensitive cathode, Cs_3Sb. The use of a 931A photomultiplier, without its glass envelope, for the detection of excited molecules is described. The detection of photons, positive ions, and metastable molecules by time-resolution and pulse-counting techniques is described. Some results are presented on the effects of different surfaces on the efficiency of detection of excited molecules. Measurements were made on Kr, Ne, N_2, CO, CO_2, H_2, N_2O, and C_2H_4. Electronically excited fragments from N_2O and CO_2 were detected and their threshold energies determined. A prominent resonant state of carbon monoxide at 10.5 eV is reported. Author (NSA)

N68-27988# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
PARTICLE IN NUCLEAR-COULOMB FIELD (THE FREDHOLM THEORY)
Yu. L. Mentkovskii 1967 39 p refs
(ITF-67-44)

The rigorous Rayleigh–Schrödinger perturbation theory and the Lippmann–Schwinger theory for particles in a nuclear-Coulomb field are constructed on the basis of a Fredholm integral equation for partial waves. Author (NSA)

N68-28006*# Stanford Research Inst., Menlo Park, Calif.
SEMICLASSICAL THEORY OF ELASTIC PERTURBATION
R. P. Marchi [1967] 23 p refs
(Contract NASr-49(07)05-019-907)
(NASA-CR-95344) CFSTI: HC$3.00/MF$0.65 CSCL 20H

The Stueckelberg formulation for transition probabilities is utilized to explain perturbation effects observed in elastic differential cross section measurements. The model based on a competing trajectory concept implies oscillating cross sections for all inelastic processes occurring by means of a curve crossing mechanism. Variations are made in the slopes of two crossing potential energy curves to determine the effect on the cross section. The model gives qualitative agreement with experiment, but definitive tests must await more accurate potential energy curves. Author

N68-28014# Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics.
FAMILIES OF REGGE TRAJECTORIES AT NONVANISHING ENERGY, 1
G. Domokos and P. Suranyi 1968 17 p refs
(KFKI-3/1968)

The parent–daughter trajectory phenomenon is studied for spinless particles in the framework of the Bethe–Salpeter equation. If the kernel of the equation satisfies some natural conditions, the partial wave amplitude is shown to possess multiple poles in the 1-plane, corresponding to a Regge-pole family. Under the same conditions a perturbation formula is given for the derivatives of trajectory functions and residues at zero momentum transfer as a function of κ, the order of daughter trajectories. Author (NSA)

N68-28015# Institutt for Atomenergi, Kjeller (Norway).
COMPARISON OF ρ_{33} MEASURED BY THE COINCIDENCE METHOD AND BY THE CHEMICAL SEPARATION METHOD

Toralf B. Skaali Dec. 1967 44 p refs
(KR-124)

Two different methods for determination of relative neptunium activity in irradiated uranium foils were investigated: a chemical separation technique for isolation of ^{239}Np and a coincidence method in which the fission product and natural background activities are suppressed relative to the neptunium counting rate. The methods were compared by measuring ρ_{28}, the ratio of epicadmium to subcadmium neutron capture in ^{238}U, for two different core configurations in the zero-power critical facility NORA. A detailed description of the separation procedure and counting technique is given together with values of ρ_{28} obtained for the lattice investigated. The two methods give results which agree within the experimental errors. Author (NSA)

N68-28022# Lyon Univ. (France). Institut de Physique Nucleaire.
SYMMETRISATION OF INTERACTION IN REARRANGEMENT COLLISIONS THROUGH THE APPLICATION OF GENERAL FOURIER TRANSFORMS [SYMETRISATION DES INTERACTIONS DANS LES COLLISIONS DE REARRANGEMENT PAR APPLICATION DE LA TRANSFORMATION DE FOURIER GENERALISEE]
Jean Guyaux (Ph.D. Thesis) Dec. 1967 31 p refs In FRENCH
(LYCEN-6784)

The study of the symmetrization of the interactions in rearrangement collisions is based on the concept that every reaction is, at the least, a three-body problem. The Schroedinger equation is therefore rewritten in the center-of-mass system. The solutions of the corresponding homogeneous equation permits a development of the wave function which is its Fourier transform in a six-space dimension. Development of the formal theory of scattering in the Hilbert space establishes that the potentials intervening in the transition matrix are three in number. The interaction is thus symmetrized. This symmetrization requires the decomposition of the initial (and final) state on the chosen base. These theoretical studies are then applied to the reactions ^{28}Si(d,p)^{29}Si and ^{16}O(d,p)^{17}. NSA

N68-28032# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
A SINGLE LEVEL ANALYSIS OF U 233 NEUTRON CROSS SECTIONS; AN n + U 233 MULTIGROUP CROSS SECTION LIBRARY
M. J. Schneider Dec. 1967 107 p refs
(WANL-TME-1721) CFSTI: HC$3.00/MF$0.65

Total, capture, and fission cross sections for $n + {}^{233}$U were simultaneously least squares fit over the energy range 0.4 to 61.4 eV using the single-level Breit–Wigner formula. Sixty-three resonances were found in this range. Good agreement was obtained between integral data and this fit to differential data for the resonance integrals of ^{233}U. Resonance parameters are given, along with brief statistical analyses of them. A multigroup cross-section library from .001 eV to 10 MeV is presented. Author (NSA)

N68-28039# California Univ., Berkeley. Lawrence Radiation Lab.
PHYSICS SEMIANNUAL REPORT, MAY–OCTOBER 1967
Nov. 1967 117 p refs
(Contract W-7405-ENG-48)
(UCRL-17876) CFSTI: HC$3.00/MF$0.65

A summary of research at the Lawrence Radiation Laboratory from May through October, 1967 is presented. This research covers both theoretical and experimental high-energy physics and nuclear physics. Computing and data handling and accelerator operation and development are also covered. NSA

N68-28041# Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.
GENOUT: A GENERALIZED OUTPUT PROGRAM FOR NUCLEAR SCIENCE REFERENCE DATA
Jack H. Owings 26 Feb. 1968 47 p refs
(Contract W-7405-ENG-26)
(K-DP-3109) CFSTI: HC$3.00/MF$0.65

GENOUT is an IBM 7090 computer program which operates on the data base represented by the cataloging and indexing of Nuclear Science Abstracts. This program provides capability to select entries from these data which meet specified bibliographic criteria and output them in a variety of formats. Citations, subject headings and modifiers, and keywords can be listed to comprise a microabstract. These can be sorted, after selection, on various fields as desired and listed with sequence numbers assigned. Then, the usual NSA indexes can be prepared to these sequence numbers. Author (NSA)

N68-28054*# Techtran Corp., Glen Burnie, Md.
TRANSFER OF RESONANCE RADIATION IN A HALF SPACE [PERENOS REZONANSNOGO IZLUCHENIYA V POLUPROSTRANSTVE]
Yu. Yu. Abramov, A. M. Dykhne, and A. P. Napartovich Washington NASA Jun. 1968 23 p refs Transl. into ENGLISH from Astrofiz. (USSR), v. 3, no. 4, 1967 p 459–479
(Contract NASw-1695)
(NASA-TT-F-11840) CFSTI: HC$3.00/MF$0.65

The Wiener–Hopf method is used to solve the problem of the transfer of resonance radiation in the approximation assuming complete frequency mixing. Nonresonance processes such as absorption of photons and damping of excited atoms are also considered. The method suggested allows known results plus a number of new results to be produced in the same manner. Asymptotic expressions are produced in explicit form for excited atom density with arbitrary line form. The influence of frequency redistribution on the behavior of the solutions is discussed. Where possible, a physical interpretation of the results produced is given. Author

N68-28056*# Scripta Technica, Inc., Washington, D. C.
MOTION OF CHARGED PARTICLES IN AN AXIALLY ASYMMETRICAL MIRROR TRAP [DVIZHENIYE ZARYAZHENNYKH CHASTITS V AKSIAL'NO-NES-IMMETRICHNOY LOVUSHKE PROBOCHNOY KONFIGURATSII]
A. N. Dubinina and Yu. N. Yudin Washington NASA Jun. 1968 8 p refs Transl. into ENGLISH from Zh. Eksperim. Teor. Fiz. (Moscow), v. 53, no. 4, 1967 p 1206–1212
(Contract NASw-1694)
(NASA-TT-F-11655) CFSTI: HC$3.00/MF$0.65 CSCL 20H

An experimental investigation has been made of the confinement time of electrons in an axially asymmetrical magnetic mirror trap, and the value has been found of the critical nonadiabaticity parameter ρ_L/R, the numerical value of which turned out to be close to the numerical value of the nonadiabaticity parameter in the case of electron motion in an axisymmetric trap. The obtained result appears to indicate that the parameter characterizing the degree of nonadiabaticity in a trap is the ρ_L/R parameter, rather than the deviation of the magnetic field from symmetry. Author

N68-28068# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
CHANGES IN GAM AND TNS CROSS SECTION LIBRARIES: NEW ACTIVATION CROSS SECTIONS
M. J. Schneider Jan. 1968 47 p refs
(WANL-TME-1746) CFSTI: HC$3.00/MF$0.65

Some recent experimental data and evaluations of activation cross sections for several nuclei are analyzed; and new GAM, TNS, and B1T libraries based on these analyses are presented. The cross sections for the isotopes ^{55}Mn, ^{115}In, and ^{32}S, and for natural Pb and Zr are analyzed. A preliminary analysis of the ^{93}Nb(n,γ) cross section is also summarized. NSA

N68-28069# Atomics International, Canoga Park, Calif.
LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC) Quarterly Progress Report, 1 Oct.–31 Dec. 1967
15 Jan. 1968 141 p
(Contract AT(29-2)-2338)
(AI-AEC-12642; QPR-2) CFSTI: HC$3.00/MF$0.65

Progress is reported on the Large Radioisotope Heat Source Capsule (LRHSC) Program. Planning and control documentation were released including the final weld development plan and the Quality Assurance Plan. Documentation methods for all phases of the program were established and implemented. Analytical support to the test program, including work directed at thermal environments, chill block requirements and the interference fit tooling requirements is described. Coating development for application of the Al_2O_3 barrier coating continued. A process for applying α phase Al_2O_3 was developed. Four coupon compatibility stacks were tested. The 100 hour test at 2000°F, and the 10 hour test at 2250°F were completed. The 1000 hour test at 2000°F and the 10 hour test at 2500°F were initiated. The significant results found to date are a general incompatibility between iron titanate and both Ta-10W and T-111. Effort was expended on the creep test systems, test techniques and instrumentation. A final approach which meets both the temperature control requirements and the visual observation requirement was verified. Author (NSA)

N68-28071# Los Alamos Scientific Lab., N. Mex.
THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM Status Report, 12-month period ending 31 Oct. 1967
H. R. Lewis Mar. 1968 5 p refs
(LA-3831, Add.) CFSTI: HC$3.00/MF$0.65

Brief theoretical discussions are presented on the following research areas: (1) Hamilton's principle and numerical solution of the Vlasov equations, and (2) the motion of a time-dependent harmonic oscillator and the motion of a charged particle in a class of time-dependent, axially symmetric electromagnetic fields. NSA

N68-28072# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
CLASSIFICATION OF IRREDUCIBLE REPRESENTATIONS OF A SEMISIMPLE COMPLEX LIE GROUP [KLASSIFIKATSIYA NEPRIVODIMYKH PREDSTAVLENII POLUPROSTOI KOMPLEKSNOI GRUPPY LI]
D. P. Zhelobenko 1967 26 p refs In RUSSIAN; ENGLISH summary
(ITF-67-23)

A short review of recent results on the theory of irreducible (not necessarily unitary) representations of a semisimple complex (and consequently noncompact) connected Lie group is presented. In particular, the complete classification of all such representations is given for a version of the statement of the problem. Author (NSA)

N68-28076# Brookhaven National Lab., Upton, N. Y.
INDUCED CAPTURE OF ORBITAL ELECTRON
L. A. Mikaelyan, V. G. Tsinoev, A. A. Borovoi [1967] 10 p refs Transl. into ENGLISH from Yad. Fiz., v. 6, 1967 p 349–352
(BNL-TR-203) CFSTI: HC$3.00/MF$0.65

The resonance capture of the orbital electron induced by the electron antineutrino is considered. For the allowed transitions, an expression is derived for the cross section averaged over the reactor $\bar{\nu}_e$ spectrum. For heavy nuclei, the cross section of the process considered exceeds the cross section of the "usual" inverse β decay $\bar{\nu}_e + A_Z \rightarrow A_{Z-1} + e^+$. Author (NSA)

N68-28078# Los Alamos Scientific Lab., N. Mex.
ANALYSIS OF MICROCAUSALITY
D. I. Blokhintsev and G. I. Kolerov 1966 8 p refs Presented at the 12th Intern. Conf. on High Energy Phys., Dubna, 5–15 Aug. 1964
(LA-TR-68-6; CONF-650-101) CFSTI: HC$3.00/MF$0.65

It is stated a priori that there is no reason to believe that metric relations in the region of small scales should be such as they are known to be from microscopic physics. Meanwhile if one proceeds from the metrics of the Einstein–Minkowski space, then it is noted that an assumption that the signal for large distances is transmitted by the particles with positive mass leads to the Green functions which disappear inside the light cone and have a singularity of the type $\delta\ (x^2)$ in this cone. On the other hand, in view of the indefinite character of the metric the introduction of any scale a, where a is elementary length, proves to be insufficient for the description of that region of space science inside of which the usual metric and causality can or may be distorted. It is also necessary to have in its arrangement a time vector $n(n^2 = 1)$, which allows the determination, in an invariant manner, of the concept of nearness of two points in the Einstein–Minkowski space. The cases of πN scattering at high energies and the elastic scattering of electrons are mentioned. NSA

N68-28079# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
THE CONVERSION FOR A CDC 6600 COMPUTER OF THE TWO DIMENSIONAL TRANSPORT PROGRAM DOT Status Report
G. Collier, G. Gibson, and R. G. Soltesz Sep. 1967 44 p refs
(WANL-TME-1680) CFSTI: HC$3.00/MF$0.65

A FORTRAN-IV, IBM 7094, version of the two-dimensional Discrete Ordinates Transport code (DOT) has been converted for use on the CDC 6600 computer. In addition, options have been added to allow cross sections which are punched in a 6E12.5 FORTRAN format as well as decimal cross sections for ODD-K to be read by the DOT program. In this report, results of r–z and r–Θ geometry calculations that have been obtained with the converted DOT program are presented, and some comparisons are made with results obtained with the ODD-K and DDF programs utilizing the same input parameters. In making these comparisons, a discrepancy has been observed in the solution of the fast flux at the outer (right) boundary in the DOT program. This discrepancy occurs only when the negative flux correction option is used in DOT for the flux calculation. Author (NSA)

N68-28094# United Kingdom Atomic Energy Authority, Culham (England). Translations Office.
EXPERIMENTS ON ADIABATIC HEATING OF ELECTRONS IN A MAGNETIC TRAP
V. G. Ponomarenko, L. Ya. Trainin, V. I. Yurchenko, and A. N. Yasnetskii Feb. 1968 12 p refs Transl. into ENGLISH from Russian
(NP-TR-1646; CTO-491) CFSTI: HC $3.00/MF $0.65

Theoretical estimates are given of the effect of adiabatic heating on the motion of charged particles in a magnetic trap. Experimental oscillograms are shown of adiabatic heating and of the dependence of the electron containment time in the trap on the magnetic field during adiabatic heating. A method of obtaining large containment times (above 500 seconds) using adiabatic heating is described. Author (NSA)

N68-28097# United Kingdom Atomic Energy Authority, Culham (England). Translations Office.
MAGNESIUM VAPOUR NEUTRALISER
V. I. Butusov, V. M. Kulygin, V. F. Zubarev, and V. S. Svishchev Oct. 1967 21 p refs Transl. into ENGLISH of Inst. of Atomic Energy, Kurchatov Rept. IAE-1394, Jul. 1967 p 1–24
(NP-TR-1642; CTO-433; IAE-1394) CFSTI: HC $3.00/MF $0.65

The proposed design of the magnesium evaporator ensures a constant density of the supersonic target jet during 8 seconds without using additional heaters to compensate for heat loss on the evaporation of the magnesium. The density of the molecular streams of slow molecules passing through the magnetic trap in OGRA-II is due to the high pressure in the chamber housing the deflecting magnet of the injector rather than to the neutralizer target. The magnesium vapor "transmitted density" in OGRA-II deriving from the neutralizer does not exceed 3.5×10^6 cm^{-3} (10% of the total transmitted density) which corresponds to a lifetime of the 70-keV protons in the trap of about 300 sec. To reduce the molecular flow of slow gas in the vessel of the magnetic trap, it is thus necessary only to reduce the pressure in the chamber housing the injector deflecting magnet. Author (NSA)

N68-28098# Tokyo Univ. (Japan). Inst. for Nuclear Study.
PHOTOPRODUCTION OF N*(1236) FROM HYDROGEN
K. Ukai, K. Takamatsu, Y. Murata, K. Mori, M. Mishina et al 25 Dec. 1967 39 p refs
(INSJ-107)

Measurements were made on the production of N*(1236) through the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ by detecting one pion pair and a proton in coincidence. The kinematical condition was chosen in such a way that the invariant mass of the detected pion and proton was in the range of the first pion-nucleon resonance. The experimental results show that the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ proceeds mainly through the 3-3 isobaric state N^{*++}. A direct comparison is given of the yield of N^{*++} with that of the rest of the channels for the present experimental condition. Author (NSA)

N68-28102# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.
PRELIMINARY SPACE-CHARGE CONSIDERATIONS IN THE AGS
J. Claus 11 Mar. 1968 37 p refs
(BNL-12356) CFSTI: HC $3.00/MF $0.65

Calculations for the beam envelope and particle motion for symmetric and nonsymmetric beams which are matched and unmatched are presented and discussed. Also, considerations for improving the model are given. NSA

N68-28103# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.
INTEGRATION OF FAST NEUTRON FLUXES BY MEANS OF THE ACTIVITY OF MN-54 PRODUCED IN IRRADIATED STEEL SAMPLES
V. Kadlec and M. Vitek Aug. 1967 29 p refs
(UJV-1885)

The use of ^{54}Fe(n,p)^{54}Mn reaction as an activation integrator of fast neutron fluxes is discussed. Arguments for a quick and accurate evaluation method of an integrator by means of a semiconductor detector with a resolution better than 1% are given and examples shown. The given method makes it possible to evaluate the integrated fast neutron fluxes directly by means of irradiated steel samples with no special detector of pure iron. Hence, the absorbed dose at any point of the irradiated specimen can be estimated. An additional advantage of this method is that there is no need of any chemical separation of ^{54}Mn from irradiated detectors and no costly iron enriched in ^{54}Fe is required. Most frequently quoted values of $\sigma_0 = 53$ mb and $T_{1/2} = 314$ d are used throughout this paper. Author (NSA)

N68-28118# Cologne Univ. (West Germany). Institut fuer Kernphysik.
TABLES OF Q VALUES FOR THREE-PARTICLE REACTIONS ON THE NUCLEI 2H TO 48CA [TABELLEN DER Q-WERTE FUER DREITEILCHENREAKTIONEN AN DER KERNEN 2H BIS 48CA]
H. T. Buschmann, H. Klein, W. Kuhlmann, and H. Stehle Bad Godesberg, W. Germany Bundesmin. fuer Wiss. Forschung Dec. 1967 94 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Wiss. Forschung
(BMWF-FBK-67-91)

Q-values for three-particle reactions were calculated; the results are summarized in tables. The incident particles considered were neutrons, protons, deuterons, tritons, ^{3}He, ^{4}He, ^{6}Li, and ^{7}Li on targets of T and the stable nuclei D to ^{48}Ca. Reactions with two light outgoing particles were selected; all the three-particle reactions leading to the same final nucleus are summarized. NSA

N68-28119# Tubingen Univ. (West Germany). Inst. for Theoretical Physics.
NUCLEAR STATES AND NUCLEAR REACTIONS IN THE REFINED CLUSTER MODEL [KERNZUSTAENDE UND KERNREAKTIONEN IM VERALLGEMEINERTEN CLUSTERMODELL]
H. H. Hackenbroich Bad Godesberg, W. Germany Bundesmin. fuer Wiss. Forschung Dec. 1967 70 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Wiss. Forschung
(BMWF-FBK-67-93)

Mathematical methods that can be used to describe nuclear bound states and reactions, starting from realistic nucleon-nucleon forces, are described. The methods are based on the approximation of the nuclear wave functions by a superposition of cluster functions. NSA

N68-28122# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.
ELASTIC SCATTERING OF TRITONS BY OXYGEN IN THE ENERGY RANGE 0.9 TO 1.7 MEV [UPRUGOE RASSEYANIE TRITONOV NA KISLORODE V INTERVADE ENERGII 0,9-1,7 MEV]
A. P. Kobzev, V. I. Salatskii, and S. A. Telezhnikov 1968 19 p refs In RUSSIAN
(JINR-P15-3756)

Elastic scattering of tritons by oxygen at the angles of 79.5, 115.5, 133, 144, and 150° in the laboratory system was investigated. The scattering is found to differ from that calculated according to the Rutherford formula. Anomalies, which can be connected with the resonances in the excitation functions of the reactions $^{16}O(t,\alpha)^{15}N$ and $^{16}O(t,p)^{18}O$, are observed in all the scattering curves. Author (NSA)

N68-28133 California Univ., Berkeley.
THE STRUCTURAL INCONSISTENCY OF THE QUANTUM ELECTRODYNAMICS OF HIGHER SPIN FIELDS
Mark Frank Sharefkin (Ph.D. Thesis) 1966 72 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-9649

A structural classification of Duffin-type Lagrangians serves to introduce several simple consistency conditions, and motivates the construction of an aberrant vector theory structurally similar to boson theories of spin ≥ 2. The corresponding minimal electrodynamics is shown to violate microscopic causality; any nonzero coupling generates terms in the equal-time self commutator of the charge density operator which are nonzero outside the light cone. The requirement that this commutator be local is therefore a nontrivial restriction on the Lagrangian, and it is not obvious that a spin-2 Lagrangian consistent with this requirement can be found. Dissert. Abstr.

N68-28149# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Atomnoi Energii.
EQUIVALENT LOCAL POTENTIAL [EKVIVALENTNYI LOKAL'NYI POTENTSIAL]
S. S. Gorodkov 1967 9 p refs In RUSSIAN
(IAE-1316)

Problems of the equivalent local potential were solved on the assumption of slowly changing potentials in the first approximation. The Perey effect formula was theoretically verified. The suitability of the Perey–Buck formulas in very high approximations was shown. The radius of the equivalent local potential of the Saxon–Woods form was found. Author (NSA)

N68-28152# United Kingdom Atomic Energy Authority, Harwell (England). Ceramics Div.

A COMPUTER PROGRAM FOR THE CORRECTION OF MEASURED INTEGRATED BRAGG INTENSITIES FOR FIRST-ORDER THERMAL DIFFUSE SCATTERING

K. D. Rouse and M. J. Cooper Apr. 1968 42 p refs
(AERE-R-5725) CFSTI: $3.00

Expressions for the contribution of first-order thermal diffuse scattering (TDS) to the measured integrated Bragg intensities of cubic single crystals are derived by extending the formulation of Nilsson. The approximation of an infinite slit height is avoided and the treatment is extended to θ-2θ (detector coupled 2:1 to the crystal) as well as ω (crystal rotating, detector stationary) scans. A computer program for correcting X-ray or neutron Bragg intensities for the contribution of first-order TDS, written for the IBM 7030, is described and an example input and output are given. Author

N68-28163# Mound Lab., Miamisburg, Ohio.

CURIE LEVELS AND ROENTGEN RATES FOR NEUTRON IRRADIATED ELEMENTS

B. D. Craft, H. L. Rook, and L. L. Bentz 22 Mar. 1968 18 p
(Contract AT(33-1)-GEN-53)
(MLM-1457) CFSTI: HC$3.00/MF$0.65

The Curie levels and Roentgen rates for one gram of an element irradiated by a reactor with a thermal neutron flux of 1×10^{13} n/cm^2/sec are presented in tabulated form. The levels in milliroentgens per hour per gram of element were calculated for 1-, 10-, 100-, and 1000-min irradiation time intervals. The concentration levels (millicuries) per gram of element were calculated for the same time intervals. These values are given for some stable isotopes (prior to irradiation) of all the elements in the periodic table from lithium (atomic number 7) to bismuth (atomic number 83). Author (NSA)

N68-28166# Brookhaven National Lab., Upton, N. Y.

THERMAL NEUTRON CROSS SECTIONS AND RESONANCE INTEGRALS FOR TRANSURANIUM ISOTOPES

A. Prince [1967] 18 p refs Presented at 2d Conf. on Neutron Cross Sect. and Technol., Washington, D. C.
(BNL-12353) CFSTI: HC$3.00/MF$0.65

A systematic procedure for estimating fission and capture thermal cross sections and fission and capture resonance integrals for transuranium isotopes is outlined. The method involves establishing a correlation between the difference of the binding energy and fission threshold ($B_n - E_f$) and the cross sections and resonance integrals. Estimated values for σ_f, σ_γ, I_f, I_γ, (ν_p), α, η, and (E_k) (average kinetic energy of fission products) for more than 280 isotopes ranging from ${}_{88}Ra^{212}$ to ${}_{106}X^{264}$ have been completed. The method of analysis and recommendations are given for possible study and improvements. Author (NSA)

N68-28169 Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark).

NEW GREEN FUNCTION TECHNIQUES IN QUANTUM MANY-BODY THEORY

M. R. Bhagavan (London Univ.) 1967 141 p refs Lectures presented at Inst. for Theoret. Phys. of the Roy. Inst. of Tech., Stockholm
(NP-17413)

A study is made of the Green function techniques devised recently. Restriction is made to system of many fermions, although the developed formalism can easily be adapted to many-boson systems. The analysis is performed for a translationally invariant system of uniform density at absolute zero temperature. The prescription for extending it to nonzero temperatures is given. Some of the well-known formal properties of the one- and two-body Green functions, including the Green function description of the concept of the Landau quasi-particle, are recapitulated. Also the method of Edwards et al. is discussed. NSA

N68-28170# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

THE NUMERICAL PROGRAM OF THE DIAGONALIZATION OF THE NILSSON MODEL IN GIER-ALGOL

M. Zielinska-Pfabe and W. Grochulski 1967 18 p
(INR-654/VII/PL)

The description of the numerical computation program for a diagonalization of the Nilsson model of atomic nucleus is given. The computation contains two cases: the old Nilsson model (Kgl. Danske V. S., Mat.-Fys. Medd., 29., No. 16, 1955) and a slightly modified version suggested recently. The calculation is limited to the case of axial symmetry. The eigenvectors and eigenvalues can be obtained for any quadrupole and hexadecapole deformation. Both programs are written in Gier–Algol. Author (NSA)

N68-28173# Princeton–Pennsylvania Accelerator, Princeton, N. J.

SPACE CHARGE EFFECTS ON BEAM EMITTANCE MEASUREMENTS

K. Prelec and A. Passner 28 Jan. 1968 18 p refs
(Contract AT(30-1)-2137)
(PPAD-636-D) CFSTI: HC$3.00/MF$0.65

The problem of measuring the emittance of a beam under strong space charge forces has been examined. The various standard experimental methods have been studied to learn the distorting effect of space charge on the measured values of emittance. The work indicates that certain methods would increase the apparent emittance while others would decrease its value. An experimental method is proposed that would reduce to a minimum the distorting effect of space charge on the measured value of emittance. Author (NSA)

N68-28174# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

DYNAMIC MOMENTS AND CURRENT ALGEBRAS

Yu. M. Shirokov 1967 19 p refs Presented at the Conf. on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, May 1967
(ITF-67-31; CONF-670544-8)

An investigation is made of some rigorous physical and mathematical properties of dynamic moments. The method provides the possibility of deriving discrete mass spectra without contradictions with theorems like that of O'Raifeartaigh. It is essential to note that these symmetries occur in bound states only rather than in reactions. Tentative suggestions about the choice of the system of commutators, and the gravitational current and its possible role in current algebras are also considered. NSA

N68-28175# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

SINGULAR POTENTIAL WITH A POWER SINGULARITY IN QUANTUM MECHANICS

V. A. Yatsun 1967 26 p refs
(ITF-67-22)

It is established that in the nonrelativistic problem of scattering by a strongly repulsive singular potential with a power singularity at the zero point, the regularization can be associated with an extension of the Schrödinger singular operator in a Hilbert space. Author (NSA)

N68-28176# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).

LADDER APPROXIMATION IN PARTIAL WAVE DISPERSION RELATIONS

F. Gutbrod Jan. 1968 17 p refs
(DESY-68/2)

The lefthand cut of the 3/2, 3/2 π-N partial wave amplitude is calculated by iterating the Bethe-Salpeter equation with nucleon exchange including a smooth cutoff. The partial wave dispersion relation is approximately satisfied, if the cutoff is chosen properly. The magnetic dipole excitation of the isobar as well as the transition form factor are determined through a dispersion sum rule retaining only a class of ladder diagrams. Author (NSA)

N68-28177# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).

VECTOR MESON DOMINANCE AND POLARIZATION

H. Fraas and D. Schildknecht Jan. 1968 16 p refs
(DESY-68/4)

The vector dominance model relates amplitudes for reactions induced by photons (e.g., π-production) to amplitudes for reactions induced by vector mesons. In the application of such relations one conventionally assumes that the vector mesons have to be polarized transversely with respect to the cms. Because of the spin rotation of a massive particle under Lorentz transformations, this choice is not well justified a priori. The main assumptions are, that the vector meson couples to a conserved current, and that for large s, the invariant amplitudes $A^{(i)}$ (s,t) (i = 1, ...6) are slowly varying functions approximately independent of the mass of the vector mesons. It is found that for large s and for both small and large t the optimum approximation of the photoproduction amplitudes is obtained if the vector mesons are in the transverse helicity states (with respect to the cms). Indeed, exactly these transverse amplitudes are independent of λ for $s >> \lambda^2$, if the contribution of $A^{(6)}$ (s,t) is assumed to be small, in addition to the assumptions mentioned above. Author (NSA)

N68-28181# Los Alamos Scientific Lab., N. Mex.

ENERGY SOURCES OF THE FUTURE WITH EMPHASIS ON THE LIGHT ELEMENTS

James L. Tuck [1967] 7 p refs Presented at the 6th IEEE Region Conf., Portland, Ore.
(Contract W-7405-ENG-36)
(LA-DC-9519; CONF-680502-2) CFSTI: HC $3.00/MF $0.65

A discussion of available power sources and their efficient application is presented. A review of fossil fuel reserves and hydroelectric and solar energy potentials is discussed. The description and aspects of nuclear fission and fusion energies are described. Author (NSA)

N68-28183# North Dakota Univ., Grand Forks. Dept. of Physics.

RADIATION DAMAGE TO SILICA STRUCTURES

Harold D. Bale 4 Mar. 1968 11 p refs
(Contract AT(11-1)-1255)
(COO-1255-5) CFSTI: HC $3.00/MF $0.65

A step scanning device and a Mo rotating anode for use in the small-angle x-ray study of radiation damage to silica glass are described briefly. Scattering studies of glass samples suggest that damage resulting from neutron irradiation is similar but not identical to effects of quenching. Radial distribution curves for compacted and noncompacted silica powder samples show a shift of the Si–Si distance from 3.1 to 2.9 Å after compaction. NSA

N68-28207# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

ACCURATE SOLUTION OF TRANSPORT THEORY PROBLEMS BY THE USE OF A NEW VERSION OF DIFFUSION THEORY

R. T. Ackroyd 1968 49 p refs Repr. of TRG-Memo-3718(R), Nov. 1966
(TRG-1568(R); TRG-Memo-3718(R)) CFSTI: HC $3.00/MF $0.65

Each group of a transport theory model is treated so that each group equation and its associated boundary conditions are replaced by spherical harmonic equations, of an odd order for the moments of the angular flux, and the associated boundary conditions for the moments. The moment equations and boundary conditions are then cast into a form with the appearance of a generalized version of multigroup diffusion theory. The even moments correspond to the group fluxes of diffusion theory in this analogy. The gradients of the even moments correspond to the net group currents of diffusion theory. At an interface the moments, i.e., the analogous group fluxes, are continuous, and if the scattering is isotropic the product of the gradient of an analogous group flux and the diffusion coefficient of diffusion theory is continuous. The principal application foreseen for the analogy is in the transport theory calculations. Author (NSA)

N68-28229# Brookhaven National Lab., Upton, N. Y.

TEMPERATURE DEPENDENCE OF QUASI-ELASTIC SCATTERING OF COLD NEUTRONS FROM LIQUID ARGON

W. S. Andrus, H. R. Muether, and Harry Palevsky (State Univ. of New York, Stony Brook) 9 Apr. 1968 12 p refs Presented at the Symp. on Inelastic Neutron Scattering, Copenhagen
(BNL-12372; CONF-680501-2) CFSTI: HC $3.00/MF $0.65

The scattering of Be-filtered neutrons from liquid Ar at temperatures of 87, 97, 111, and 124°K and at scattering angles of 45, 65, and 80° was investigated. The quasielastic width was obtained as a function of the reciprocal of the temperature. The quasielastic widths were compared with the predictions of Singwi's model (Phys. Rev., 13: A969(1964)) for coherent scattering from liquids. NSA

N68-28250*# Northrop Corp., Hawthorne, Calif. Corporate Labs.

STUDY ON A TECHNIQUE FOR DETECTING PHOTONS IN THE 100–1000 Å WAVELENGTH REGION Final Report, 15 Apr. 1965–15 Oct. 1967

O. P. Rustgi Washington NASA Jun. 1968 136 p refs
(Contract NAS12-3)
(NASA-CR-1096) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A general survey of the various modes of interaction of electromagnetic radiation in the 100–1000 Å region with matter was conducted. These interactions were analyzed in terms of photon efficiency, wavelength cut-off, minimum photon flux required for detection of these effects, ease of wavelength resolution through selective detection, and ease of fabrication and calibration of resultant detectors. The transmittance of thin films and photoionization in gases are selected as the possible interactions resulting in selective detectors. Thin films of aluminum, bismuth, indium, titanium, and tin are prepared and supported on mosaic glass. Techniques are developed to seal the mosaic glass with a film to the metallic plate. This plate is then used as a filter as well as a window for a rare gas ion chamber to form the resultant selective detector. Spectral response characteristics of selective detectors using (1) bismuth film with neon, argon, and krypton; (2) indium film with argon, krypton, and xenon; and (3) titanium film with argon, neon, and helium are presented with emphasis on selectivity of response. Author

N68-28265*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COUPLED-CHANNELS METHOD FOR REARRANGEMENT COLLISIONS

Howard C. Volkin Washington Jul. 1968 70 p refs
(NASA-TN-D-4633) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The classification and construction of open-channel projection operators for a given rearrangement collision are developed from the unifying viewpoint of their projective spaces in the total Hilbert space of the system. The representative case of the pickup or stripping process is treated. The open-channel projection operators are constructed from the channel-subspace projectors with the help of generalized channel transformation functions. Various projection operators that can be obtained in closed form are identified. The use of the projection operators to obtain coupled equations describing the reaction is discussed, including their application to generalized potential models. Author

N68-28292# United Kingdom Atomic Energy Authority, Harwell (England). Nuclear Physics Div.

MEASUREMENTS OF FAST NEUTRON SPECTRA IN REACTOR MATERIALS

M. S. Coates, D. B. Gayther, and P. D. Goode Feb. 1968 41 p refs
(AERE-R-5364) CFSTI: HC$3.00/MF$0.65

A series of neutron energy spectra emerging from spherical shells of natural uranium, polyethylene, graphite and sodium have been measured in the energy region 300 eV to 6.5 MeV. The time of flight method was used with a 60 m path and a pulsed source of fast neutrons provided by the 45 MeV linear accelerator. The source was located at the centre of the shell and spectra leaving the surface at 0° and 45° to a radius vector were determined. In addition a few measurements were made of spectra in the 0° direction from different penetration depths into the shell wall. The source was designed to emit neutrons isotropically and the aim of the measurements was to provide spectra in simple one dimensional systems in order to test the nuclear data sets used in reactor calculations. The experimental method is described in detail and some comparisons based on discrete ordinate solutions of the Boltzmann equation are presented. Author

N68-28293*# Stanford Research Inst., Menlo Park, Calif.

HEAVY PARTICLE COLLISIONS

Felix T. Smith [1968] 22 p refs
(Contract NASr-49(07)05-019-907)
(NASA-CR-95352) CFSTI: HC$3.00/MF$0.65 CSCL 20H

An overview of heavy particle collisions is limited to diatomic collisions and focused on the energy range above the thermal one; and the principal processes considered are elastic scattering and inelastic processes involving electronic excitation, ionization, and electronic energy or charge transfer. The types of phenomena being measured as well as the information these measurements provide about interatomic interactions are discussed using illustrative examples. M.W.R.

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N68-26973*# Avco-Everett Research Lab., Everett, Mass.

STUDY OF PLASMA RADIATION SHIELDING Final Report

May 1968 99 p refs
(Contract NAS8-20310)
(NASA-CR-61640) CFSTI: HC$3.00/MF$0.65 CSCL 20I

The plasma radiation shield is an active device using free electrons, electric fields, and magnetic fields for the purpose of shielding astronauts from energetic solar flare-produced protons. The concept of plasma radiation shielding is reviewed in the light of current studies. The available evidence indicates that the concept is physically sound, but important practical questions remain in at least two areas: these have to do with establishment and control of the extremely high voltages required, and with integration of the concept into a realistic space vehicle design. Author

N68-26974# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SYSTEM FOR HIGH-SPEED REGISTRATION OF SPECTRAL-LINE CONTOURS

E. P. Kruglyakov and Yu. Ye. Nesterikhin 10 Aug. 1967 16 p refs
Transl. into ENGLISH of the Publ. "Sistema Dlya Sverkhskorostnoi Registratsii Konturov Spektralnykh Linii" Novosibirsk, Akad. Nauk SSSR, Inst. Yadernoy Fiz. Sibirsk., 1966 p 1–12
(FTD-MT-24-84-67; AD-668291)

During experiments with high-temperature plasma investigation of spectra of fast-flowing chemical reactions, as well as other aspects, make it necessary to record the form of spectral lines in periods shorter than the time duration of the process being investigated. Such demands require a device with high time resolution and large amplification. Spectral lines can be used in a number of cases to determine density and temperature of plasma. In the article a description is given of an improved device, a double converter, its construction, and principles of operation. The device tested showed that with its help it becomes possible to produce registration of contours of spectral lines in times up to 10 to the -8th power s and less. The double converter also permits multiple recording of both separate lines and also sections of spectrum, and it can be used for study of flow in cylindrically symmetric objects. Finally, it can serve as a photomultiplier with improved signal-to-noise ratio during study of weakly luminescent objects. Author (TAB)

N68-27010# Leeds Univ. (England). Electrical and Electronic Engineering Dept.

THE INFLUENCE OF A D.C. CROSSED MAGNETIC FIELD ON THE ELECTRICAL DISCHARGE CHARACTERISTICS OF GASES IN THE TOWNSEND REGION Final Scientific Report, 1 Sep. 1964–30 Sep. 1967

Albert E. D. Haylen and C. L. Dargan 13 Oct. 1967 56 p refs
(Contract AF 61(052)-612)
(AFCRL-68-0017; AD-668528)

The influence of a crossed magnetic field on a gaseous Townsend discharge in nitrogen, hydrogen, argon and ethane for uniform field gap distances between 0.3 and 1.2 cm at pressures from 0.5 to 700 torr using a magnetic field up to 7500 gauss, can be adequately accounted for by the equivalent pressure concept. On this basis formulae for the sparking voltage in a crossed magnetic field are derived which agree well with the experimental results. A new method for determining the important electron-molecule collision frequency from sparking voltage data is described; the values so derived for N2 and H2 agree with those reported in the literature and those for Ar and C2H6 are new. Pre-breakdown ionization current measurements were made in Ar and N2 for H/P up to 2000 g/torr and for 30 m= E/P or = 1000 yv/cm/torr. The measured values of the primary ionization coefficient in N2 agree well with the calculated ones for 200 ur = E/P or = 500. Finally a probe method is described to study the lateral movement of a Townsend discharge; this should make it possible to determine the discharge propagation velocity at a later stage. Author (TAB)

N68-27060# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.

REACTION RATES AND ENERGY DISTRIBUTIONS DURING IONIZATION AND RECOMBINATION PROCESSES IN OPTICALLY THIN PLASMAS

Maciej J. Zgorzelski Feb. 1968 59 p refs
(Contract Nonr-1841(93))
(Publ.-68-1; AD-668972)

A method for calculating the nonequilibrium distribution function for excited states of neutral atoms in optically thin three-component (ions, atoms, electrons), singly ionized, electrically neutral plasma is presented. With the aid of this function, reaction rates for ionization and recombination processes may be calculated.

The numerical calculations for atomic hydrogen plasma give recombination rates slightly higher than those obtained by Bates et al. (D. R. Bates, A. E. Kingston, R. H. P. McWhirter, Proc. Roy. Sec. vA267, p297, 1963). Furthermore, for the optically thin case, a dependence of the ionization and recombination rate on the character and magnitude of the departure from equilibrium, as well as an electron density and the degree of resonance radiation trapping, was found and evaluated numerically for hydrogen. Author (TAB)

N68-27074 Michigan Univ., Ann Arbor.
COLLISIONS IN IONIZED GASES
Jordan David Lewis (Ph.D. Thesis) 1966 176 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-8299

This dissertation is a study of the description and effects of particle interactions in ionized gases. The principal results are: (1) An expansion theorem for the linearized Fokker–Planck collision operator for each component of a two-component fully ionized gas, and (2) A description of photon scattering from a partially ionized gas. It is shown that the Fokker–Planck collision operator generates a complete, continuous set of velocity-space eigenfunctions, for which high-speed asymptotic forms are found. Since the set is continuous, the expansion formula has the form of a generalized Fourier integral. The effect of neutral atoms on the spectrum of photons scattered by electrons in a partially ionized gas is shown to be primarily a reduction in height and increase in width of the two electron-plasma "wings." The scattered photon spectrum is described for several characteristic cases. Dissert. Abstr.

N68-27080 State Univ. of Iowa, Iowa City.
NUMERICAL STUDIES OF THE NON-LINEAR VLASOV EQUATION
Thomas P. Armstrong (Ph.D. Thesis) 1966 154 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-2588

The numerical integration of the initial-value problem for the non-linear Vlasov equation was studied. The Vlasov equation is used to describe the dynamics of a "collisionless," one-dimensional, classical electron gas confined between two perfectly reflecting boundaries. Only the long-range Coulomb interactions of the electrons are considered; effects associated with the discrete structure are neglected. The numerical results obtained for non-linear Landau damping compare well with similar results obtained by Knorr. A general statement of the results on stable initial conditions is: As the degree of non-linearity of the initial conditions is increased, the deviation from linear Landau damping appears sooner and is more severe. In some cases damping was observed to cease. Curves showing the time dependence of the damping decrement are derived and compared with predictions of non-linear theories.
Dissert. Abstr.

N68-27164# Rydbeck Research Associates, Fjaras (Sweden).
COUPLED WAVE EQUATIONS FOR MULTI-MODE INHOMOGENEOUS MEDIA, 2
A. Hjalmarson 15 Aug. 1967 76 p refs
(Contract AF 61(052)-864)
(AFCRL-67-0644; SR-2; AD-668456)

CONTENTS:

1. ON THE TRANSFORMATION OF THE WAVE EQUATIONS OF AN INHOMOGENEOUS MULTI-WAVE SYSTEM TO COUPLED MODE FORM 38 p refs (See N68-27165 16-25)

2. ON INHOMOGENEOUS WAVE NUMBERS FOR LONGITUDINAL PROPAGATION IN A MAGNETO-IONIC MEDIUM 32 p refs (See N68-27166 16-25)

N68-27165# Rydbeck Research Associates, Fjaras (Sweden).
ON THE TRANSFORMATION OF THE WAVE EQUATIONS OF AN INHOMOGENEOUS MULTI-WAVE SYSTEM TO COUPLED MODE FORM, SECTION A
In its Coupled Wave Equations for Multi-Mode Inhomogeneous Media, 2 15 Aug. 1967 38 p refs (See N68-27164 16-25)

By means of matrix formalism any linearized form of wave equations in total fields, which govern the propagation of an inhomogeneous multi-mode system, can be transformed to coupled mode form. Various types of mode representations and coupled mode equations are obtained. Modes can be defined by means of homogeneous and inhomogeneous models. Furthermore the nature and the properties of the mode definition depend upon the choice of original wave equations in total fields. The physical interpretation of the mode representation is a very important part of a coupling theory. Author

N68-27166# Rydbeck Research Associates, Fjaras (Sweden).
ON INHOMOGENEOUS WAVE NUMBERS FOR LONGITUDINAL PROPAGATION IN A MAGNETO-IONIC MEDIUM, SECTION B
In its Coupled Wave Equations for Multi-Mode Inhomogeneous Media, 2 15 Aug. 1967 32 p refs (See N68-27164 16-25)

The problem of mode representation and mode coupling essentially is a question of definition. To illuminate this situation the case of longitudinal propagation in an inhomogeneous magneto-ionic medium is treated by means of homogeneous, and inhomogeneous mode representations. Although the medium is assumed to be loss-less, the inhomogeneous wave numbers show up attenuation terms. The physical explanation of this phenomenon is that the inhomogeneous modes are slowly variable linear combinations of homogeneous modes. The attenuation terms of the inhomogeneous wave numbers just indicate the gradual change of composition of the various inhomogeneous modes. Author

N68-27182 Pennsylvania Univ., Philadelphia.
ELECTRON DENSITY GROWTH IN AN INITIALLY TENUOUS PLASMA IN RESPONSE TO A SUDDENLY APPLIED ELECTROMAGNETIC WAVE
Laird Powell Bradley (Ph.D. Thesis) 1966 159 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-7824

The transient electron growth in an unbounded, initially weakly ionized plasma under the influence of an intense, suddenly applied electromagnetic wave is theoretically analyzed. The mutual interaction of the applied field and electron density created by it leads to a nonlinear formulation, and an illustrative case is therefore numerically examined. The case consists of an antenna focused in the D region of the ionosphere. The steady-state solution of this case is discussed by Lombardini. (L 1) The results of a one-dimensional analysis, axially representative of the discharge, and a three-dimensional analysis are detailed with the following notable points. In response to the applied field, a plasmoid is generated which grows first exponentially in magnitude, and abruptly commences to move toward the source at approximately constant velocity. In magnitude, the peak density reaches a maximum and then relaxes to its lower steady-state value. Dissert. Abstr.

N68-27202*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ACCELERATION OF LIQUIDS IN TWO PHASE NOZZLES
D. G. Elliott and E. Weinberg 1 Jul. 1968 50 p refs
(Contract NAS7-100)
(NASA-CR-95146; JPL-TR-32-987) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Two phase nozzle flow of liquid drops mixed with a gas is analyzed for both the one component and the two component cases. Drop volume, drop breakup and vaporization, variable fluid properties, and solubility of the gas in the liquid are taken into account. Computer programs employing the analysis provide gas and liquid velocities and temperatures, as well as drop diameter, as a function of distance through a nozzle when initial conditions and fluid properties are specified. Wall shear and boundary layer growth are also computed, and an option provides the optimum (maximum exit velocity for given length) nozzle contour. Calculations for typical fluids illustrate the effect on nozzle exit velocity of nozzle contour and length, initial drop size, mixture ratio, and pressure ratio. Nozzle experiments with nitrogen–water mixtures and Freon–water mixtures show that actual velocities and flow rates agree with the analysis within 5%. Author

N68-27220 Michigan Univ., Ann Arbor.

A SPECTROSCOPIC STUDY OF AN UNDEREXPANDED ARGON PLASMAJET

Stuart Wayne Bowen (Ph.D. Thesis) 1966 358 p
Available from Univ. Microfilms: HC $16.20/MF $4.60 Order No. 67-8219

Argon, heated to 5000°K at 7 atmospheres in a DC arc plasma generator, was expanded through a sonic orifice into the atmosphere, forming a self luminous plume with the characteristic underexpanded jet structure. The absolute intensity of the continuum radiation, as well as the absolute intensity of the line radiation from argon and the Ca and Ba and H impurity lines, was spectroscopically measured. The Stark broadened profiles of the hydrogen Balmer series yielded the electron density. The various measurements allowed calculation of the absolute temperature, the Boltzmann temperature and the Saha temperature, which were compared to the kinetic temperature at various points in the jet. Observations point to a large, excess population of highly excited argon atoms, which persist, in spite of the large number of collisions, out into the plume, and which can be deexcited by collisions of the second kind. In order to explain the very large concentrations of excited argon atoms, the trapping of the argon resonance radiation up near the very hot arc was considered. Dissert. Abstr.

N68-27322 Stanford Univ., Calif.

LANDAU WAVES

Thomas Charles Simonen (Ph.D. Thesis) 1967 154 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-7973

This report describes a comprehensive theoretical and experimental study of Landau's electrostatic space-charge waves in isotropic hot electron plasmas. The signal spreading from a steadily oscillating dipole sheet is described by an electrostatic Green's function which is synthesized from the spectrum of Landau waves. Numerical results for a Maxwellian plasma show that this signal is rejected below the plasma frequency, penetrates deeply into the plasma slightly above it, and is strongly damped for higher frequencies. Close range transmission between rf probes is characterized by the exponentially decaying fundamental Landau wave. At larger distances the signal decays as $\exp(-x^{2/3})$ due to the persistence of higher order Landau waves, or even more slowly, as $1/x$, if rf currents circulating through ground connections become important. The experiment employs gridded rf probes to excite and detect electrostatic waves within a quiescent collision-free sodium plasma at thermodynamic equilibrium. Exponentially decaying waves with phase velocities between 1.5 and 3 times the electron thermal speed 3×10^7 cm/sec are observed. Dissert. Abstr.

N68-27323 Arizona Univ., Tucson.

ON THE RADIATION FROM SOURCES IN LAYERED MEDIA INCLUDING MAGNETOPLASMA

Robert Ray Schell (Ph.D. Thesis) 1967 147 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8806

Propagation of Very Low Frequency (VLF) radio waves along the magnetic equator of the earth is considered. A flat-earth geometry is assumed wherein the earth is represented by a plane surface impedance and the ionosphere by a two layer plasma. The lower region is a vertically stratified plasma with a DC magnetic field parallel to the earth, while the upper region is a homogeneous plasma. The source of electromagnetic waves is a magnetic line current which is parallel to the DC field and located in either the waveguide region between the earth and ionosphere or in the ionosphere. Under these conditions, the propagation in the inhomogeneous, anisotropic plasma is governed by a single, second order differential equation which involves the components of the inverse permittivity tensor. Two specific cases are considered, for the variation of the inverse permittivity tensor as a function of height, which lead to exact solution of the relevent differential equation. Dissert. Abstr.

N68-27401*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

PARTITION AND RECOMBINATION ENERGY IN THE DECAYING RARE GASES PLASMAS

Che Jen Chen 1 Oct. 1967 10 p refs Presented at the 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna, 27 Aug.–2 Sep. 1967
(Contract NAS7-100)
(NASA-CR-89819) CFSTI: HC $3.00/MF $0.65 CSCL 20I

In the collisional-radiative electron-ion recombination regime, the energy liberated from each recombination is partly carried away by a third colliding free electron and partly transformed into radiation. The partition of the energy among the electrons and radiation is obtained by comparing the probability of electron collisional deexcitation at different atomic-energy states, calculated by using Gryzinski's formulation, and the spontaneous transition probability of bound electrons to all lower states evaluated by using the sum rule of line strength and the central field approximation. A recombination-dominated decaying plasma is produced by a discharge tube energized with a capacitor bank. After cessation of the discharge current, the electron density, electron temperature, and atom temperature are measured by using both microwave and electrostatic probes, the spectral-line ratio method, and a fast-rise-time resistance thermometer, respectively. The partition of the recombination energy under different conditions for He, Ne, Ar, Kr, Xe gases is determined from a solution of the electron energy equation. The experimental results are in good agreement with the theoretical predictions. The oscillator strength of the resonance lines for the five rare gases are also presented. Author

N68-27424 Michigan Univ., Ann Arbor.

ION CYCLOTRON INSTABILITIES IN AN INHOMOGENEOUS PLASMA

William Morris Farr (Ph.D. Thesis) 1966 127 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8250

A general dispersion equation for the propagation of electromagnetic perturbations in inhomogeneous, anisotropic plasma in a magnetic field is derived and analyzed for stability. For electrostatic modes with frequency near integral multiples of the ion cyclotron frequency propagating at arbitrary angles to the magnetic field and the direction of inhomogeneity, stability criteria are obtained depicting the effects of density gradients, field curvature, and various ion velocity distributions. For modes propagating normal to both the magnetic field and the density gradient a stability criterion relating field curvature and density gradients is obtained where it is shown that such modes can be unstable in mirror-type field configurations. In a plasma with a cold ion specie in addition to the hot components a previously obtained stability criterion for homogeneous plasma is modified to include spatial variations in plasma density and it is shown that the inhomogeneity has an adverse effect in the case of outward propagation from a cylindrical plasma. Dissert. Abstr.

N68-27559*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ON THE THEORY OF STARK BROADENING OF SPECTRAL LINES IN A PLASMA

G. K. Oertel 5 Nov. 1966 14 p refs Presented at the 8th Ann. Meeting of the Am. Phys. Soc., Div. of Plasma Phys., Boston, 2–5 Nov. 1966

(NASA-TM-X-59416) CFSTI: HC$3.00/MF$0.65 CSCL 20I

The theory of Stark broadening of isolated spectral lines by electrons in a plasma was developed by Griem, and numerical results were obtained for a large number of neutral and singly ionized spectral lines. Large discrepancies between measured and predicted widths of ion lines have led to a reinvestigation of the underlying assumptions. It is shown that the calculated widths do not change by more than a few percent as a result of certain corrections. The effect of different strong collision cutoff procedures is as important but still far too small to explain the experimental results for ions. Debye shielding must often be taken into account in the electron density determinations from broadening of neutral lines in typical experiments and was therefore built into a computer program for electron impact widths. The results are compared with estimates on the basis of the usual procedure for estimating Debye shielding effects. Author

N68-27576# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FLOW AROUND A BODY BY A FLUX OF STRONGLY RAREFIED PLASMA [OB OBTEKANII TELA POTOKOM SIL'NO RAZREZHENNOY PLAZMY]

N. T. Pashchenko *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 1–13 refs (See N68-27575 16-23)

The author considers the high velocity flow of a highly rarefied plasma around a stationary charged body. Assuming that the perturbations produced by the body are small and that the Debye sphere is small in comparison to the dimensions of the body, the field potential and the parameters of flow are calculated. In a system of coordinates rigidly attached to the body, the system of equations for the self-consistent field is given, after nondimensionalizing all quantities the solution for the potential was obtained. As an illustration, a specific example was worked out for the case of flow around a cylinder. Author

N68-27577# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DIFFUSION AND CONDUCTIVITY IN A PARTIALLY IONIZED MULTITEMPERATURE GAS MIXTURE [DIFFUZIYA I PROVODIMOST' V CHASTICHNO IONIZOVANNOY MNOGOTEMPERATURNOY GAZOVOY SMESI]

V. A. Polyanskiy *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 15–25 refs (See N68-27575 16-23)

The author presents the expressions for the diffusion current and generalized coefficients of diffusion in a partially ionized gas mixture with different component temperatures sustained by an electromagnetic field. For the starting point in this analysis, he takes the set of transport equations obtained from kinetic equations with the 13-moment method. The Landau type collision integrals were used for particles interacting through Coulomb forces, and Boltzmann type integrals were used for neutral particles. Starting from the macroscopic equations and Maxwell's equations, expressions were derived for the generalized Ohm's law, for the mobility coefficients, and for the conductivity, and for the mass flow current. Author

N68-27581# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ASYMPTOTIC METHODS OF HYDRODYNAMIC THEORY OF STABILITY [ASIMPTOTICHESKIYE METODY GIDRODINAMICHESKOY TEORII USTOYCHIVOSTI]

G. M. Zaslavskiy, S. S. Moiseyev, and R. Z. Saldeyev *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 69–86 refs (See N68-27575 16-23)

The authors present an asymptotic method for solving a differential equation of the fourth order. Several problems in the hydrodynamic theory of stability and problems of frequency transformation in magnetic hydrodynamics and plasma physics can be described by the fourth order equation of this type. The differential equation is given as $\alpha d^4\psi/d\xi^4 - U_2(\xi,\kappa,\omega)d^2\phi/d\xi^2 + U_1(\xi,\kappa,\omega)\phi = 0$, where α is a minor parameter, ξ—a coordinate variable, and ω is a frequency variable. The solution by asymptotic method is demonstrated for the weak case where $U_2 = Ux$, $x < 1$, $U \approx 1$, and for the strong case wherein complex variables are introduced. The author demonstrated that the classification of solution cases can be related to certain inequality relationships between α and β. A discussion is given concerning plasma instability in gravitational field. Author

N68-27596# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE STRUCTURE OF FLOW IN ELECTRODISCHARGE SHOCK TUBES [O STRUKTURE POTOKA V ELEKTRORAZRYADNYKH UDARNYKH TRUBKAKH]

M. I. Vorotnikova and R. I. Soloukhin *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 225–231 refs (See N68-27575 16-23)

Pressure measurement techniques, using piezoelectric counters and other probe methods, are compared with optical charts to determine the state of a gas behind shock waves generated in electric discharge shock tubes in order to determine more accurately departures from homogeneity. The discharge takes place in air at 0.2 mm Hg pressure. The results of pressure measurement and photomultiplier records on the oscillograph agree to within 0.1 μsec. A plot of absolute pressure versus shock velocity behind the shock waves shows measured values to be 50% lower than calculated values. This discrepancy is attributed primarily to experimental errors and possible nonequilibrium effects in the nonthermal plasma. Measurements were made on shock stand-off distance over a cylindrical obstacle placed inside the shock tube. Once more a discrepancy was observed between calculated and measured Mach number values, indicating the absence of a clear demarcation between thermal and discharge plasmas in electromagnetic shock tubes at pressure levels below 1 mm mercury. Author

N68-27600# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

BREMSSTRAHLUNG OF AN ELECTRON DURING SCATTERING BY NEUTRAL ATOMS TAKING INTO ACCOUNT COLLISION CORRELATION [TORMOZNOYE IZLUCHENIYE ELEKTRONA PRI RASSEYANII NEYTRAL'NYMI SUCHETOM KORRELYATSII STOLKNOVENIY]

Yu. P. Rayzer *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 251–255 refs (See N68-27575 16-23)

A formula for the radiation power, containing the frequency factor, is derived by the direct consideration of the retardation radiation of electrons during collisions with neutral atoms and by taking into account the correlations between the collisions. In classical electrodynamics an electron undergoing accelerated motion radiates an amount of energy in the interval ω to $\omega + d\omega$, where w_ω is the Fourier component of acceleration. The present author expresses $w(t)$ directly and derives an expression where t_k is the instant of the k-th collision, and Δv_k is the corresponding change in the velocity. Author

N68-27601# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MEASUREMENT OF FLOW RATE OF LIQUID IN A ROUND PIPE BY THE MAGNETOHYDRODYNAMIC METHOD [IZMERENIYE RASKHODA ZHIDKOSTI V KRUGLOY TRUBE MAGNITOGIDRODINAMICHESKIM METODOM]
A. Ye. Yakubenko *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 257–262 ref (See N68-27575 16-23)

The magnetohydrodynamic method for measuring the rate of flow of a fluid through a circular pipe is discussed. This method is based on the relationship between the flow rate and the potential difference between the electrodes. The relationship is theoretically derived in this paper; the equations governing the axisymmetric flow of a conducting fluid under a transverse magnetic field and the equation of Ohm's law are solved. Author

N68-27701*# California Univ., La Jolla.
PHYSICAL PROCESSES IN THE MAGNETO-PLASMADYNAMIC ARC Semiannual Report, Sep. 1967–Mar. 1968
R. Lovberg May 1968 34 p refs
(Grant NGR-05-009-030)
(NASA-CR-95144; SAR-4) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Experiments directed toward magneto-plasmadynamic beahvior within its region of current flow were performed on a tungsten cathode which achieved about 3400°K in pulsed operation. Magnetic field probes and current loops determined that the arc had the form of a rotating spoke with uniform electron temperatures throughout and an ion density nearly independent of radius. The plasma within the current spoke was counterstreaming radially inward. Although no aximuthal currents were detected in the body of the arc, a current of about 50 amperes was flowing azimuthally in the anode sheath with the resulting $J \times B$ force directed inward and of sufficient magnitude of overcome the net centrifugal force. Ions seemed to carry one-third of the radial arc current with the electrons carrying the remainder. G.G.

N68-27715 Utah Univ., Salt Lake City.
DOUBLE-STREAM INTERACTIONS IN ELECTRON BEAMS AND IN SEMICONDUCTORS
Douglas Allen Christensen (Ph.D. Thesis) 1967 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-10301

A general mathematical analysis of the propagation and coupling characteristics of the waves in a system of two charged-particle streams is developed in the first part of this paper. Both of Maxwell's equations are combined with an a-c Lorentz force equation describing two moving streams of finite dimension immersed in a magnetic field, and a pair of coupled wave equations for the fields in the system are derived. When the wave equations are uncoupled, expressions for the fields can be obtained. It is then possible to match boundary conditions for specific cases and thus obtain determinantal equations whose solutions yield the propagation and coupling properties of the waves in each case. Since no slow-wave approximation is made, fast-waves, cyclotron waves, and space-charge waves are all present in the analysis. Dissert. Abstr.

N68-27754*# Pittsburgh Univ., Pa. Dept. of Chemistry.
THE PRODUCTION OF ATOMS AND SIMPLE RADICALS IN GLOW DISCHARGES
Frederick Kaufman 23 Mar. 1967 28 p refs Presented at the Symp. on Chem. Reactions in Elec. Discharges, 153rd Meeting of the Chem. Soc.
(Grant NsG-416)
(NASA-CR-95216; SRCC-40) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The mechanisms of dc and ac discharges are described with emphasis on high frequency electrodeless discharges and the simple geometry often encountered in rapidly pumped steady-state flow systems at pressures near 1 torr. The processes of a glow discharge are discussed with respect to the diffusion of charged species, electron-ion and ion-ion recombination, electron attachment and detachment, charge-transfer and ion-molecule reactions, excitation and dissociation, and electron impact ionization. Evidence is cited for catalytic effects in the production of atomic species such as H, N, or 0 in glow discharge of their diatomic gases. Details are given on the processes of oxygen, hydrogen, and nitrogen discharges, and the discharge chemistry of more complicated systems is briefly discussed. B.S.D.

N68-27798 Washington Univ., St. Louis, Mo.
MEASUREMENT OF PLASMA PARAMETERS USING A RADIAL WAVEGUIDE
John Harry Mullen (D.Sc. Thesis) 1967 144 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-9389

This dissertation presents a new microwave method in which a radial waveguide is used to measure complex relative dielectric permittivity. The method is especially suitable for making accurate measurements of the permittivity and thus the electron density and effective collision frequency of an ionized flowing plasma cylinder. This new technique minimizes the usual field problem encountered when microwave plasma diagnostics are used. Theoretical and design limitations of this new method are investigated and experimental results are obtained using solid dielectric samples and a radio frequency heated carbon dioxide and argon plasma. The maximum percent standard error of estimate of the permittivity is shown to be less than 4.8% for solid dielectric columns and less than 9.8% for the electron density of the plasma columns. Dissert. Abstr.

N68-27808# Illinois Univ., Urbana. Gaseous Electronics Lab.
STUDIES OF HIGH DENSITY PLASMA WITH GASEOUS LASERS Final Report
Joseph T. Verdeyen Mar. 1968 12 p refs
(Contracts DA-ARO(D)-31-124-G582; DA-ARO(D)-31-124-G944)
(AROD-4832-9-P; AD-668928)

The object of the work was the development of a diagnostic tool--the spherical laser interferometer--to a state where it could be used reliably for the study of high density plasmas. This goal was successfully achieved. A brief review is given of plasma studies using this tool. TAB

N68-27817 Texas A&M Univ., College Station.
HYDROMAGNETIC WAVE PROPAGATION IN A MAGNETICALLY CONFINED PLASMA
Daniel Lester Hollis, Jr. (Ph.D. Thesis) 1967 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9787

Theta pinch plasma characteristics are described by equations for the particle density, electric field, and magnetic field as functions of radial position in cylindrical geometry. These equations are based on a position function which relates the ion density to distance from the region of uniform plasma near the centerline of the theta pinch. The product of this position function and a Maxwell–Boltzmann distribution as a function of gyration radius is integrated over a finite range of gyration radii to yield the particle density profile. It is postulated that all ion gyration centers are located within a radial boundary, r_1, and, as a result, the limits of integration are bounded. The particle density profile developed in this way is more nearly monoenergetic than that of the pure Maxwellian distribution. The magnetic induction equation as a function of particle density is obtained from the hydromagnetic formulation of the momentum equation. Dissert. Abstr.

N68-27823 Rensselaer Polytechnic Inst., Troy, N. Y.

AN EXPERIMENTAL INVESTIGATION OF THE CONDUCTION OF ELECTRIC CURRENT BETWEEN COLD ELECTRODES IN SHOCK-IONIZED AIR PLASMAS

Roger F. Hoppmann (Ph.D. Thesis) 1966 116 p

Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-9282

The conduction of electric current between cold electrodes in a high-velocity shock-ionized air plasma has been studied experimentally in order to investigate the conduction mechanisms involved. Current-voltage characteristics were measured in the ionized test flow behind the incident shock wave in an arc-driven shock tube. The electrode configuration employed in the experiments was of a shielded type. The experimental data for the lowest range of electrode potentials are compared with the results of a recent theoretical analysis and the agreement is shown to be satisfactory. In the intermediate range of electrode potentials, a mechanism, which is based on a simple ionic resistor model, is proposed to provide a possible explanation of the experimental data. In all ranges of electrode potential employed in the present research, the cathode boundary layer is found to play a dominant role in controlling the flow of current. Electrical breakdown was observed in some cases when high electrode voltages were employed. Dissert. Abstr

N68-27843 Oklahoma Univ., Norman.

ANALYTICAL SOLUTIONS FOR A CONTINUUM, PARALLEL PLATE, ELECTROSTATIC PROBE

Michael Devonne High (Ph.D. Thesis) 1967 114 p

Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-9488

The theory for the flow of a weakly ionized gas through a parallel-plate, continuum, electrostatic probe is developed. The flow is separated into three distinct regions: (a) the inviscid, neutral core where electron conduction maintains the continuity of current between the two plates; (b) the viscous, quasi-neutral boundary layer in which the charged particle flow is similar to ambipolar diffusion; and (c) the one-dimensional, collision dominated, space-charge sheath. Analytical solutions, matched at the boundary of each region, are presented for the electron temperature in equilibrium with the gas temperature and for the electron temperature constant at its free-stream value. A criterion is given which may be used to determine whether electron thermal equilibrium exists through the boundary layer. It is shown that the sheath voltage drop comprises approximately sixty percent of the total plate voltage drop. Expressions are developed from the solutions which allow the use of experimental data to determine the free-stream electron density and temperature. Dissert. Abstr.

N68-27906# Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Aero Propulsion Lab.

ANALYTICAL AND EXPERIMENTAL CHARGED-PARTICLE TRAJECTORIES IN MIRROR-CUSP MAGNETIC FIELDS

Elmer White Feb. 1968 86 p refs

(AFAPL-TR-67-91; AD-669055)

The report reviews the derivation of the equations for generating simple magnetic fields from infinitely thin closed-current loops, infinitely thin straight current-carrying elements, and rectangular cross-sectioned coils, as well as some techniques for generating complex magnetic fields by combining simple magnetic-field-generating elements. A modified Runge Kutta type integration is employed along the path of a charged-particle orbit to show that, within a small element of the orbit, the average velocity is such that the instantaneous value of the magnetic moment of an energetic charged-particle exhibits a relative error of 0.0001 to 0.000001. The requirement of adiabaticity and its application to singly charged-particle motion in positive gradient magnetic fields is reviewed. Relative error in the computations is due to the integration techniques employed by the various computer codes. An analytical effort was conducted which applied the computer technique to a study of magnetic mirror-cusp plasma confinement systems. The computer analysis found the machine to be adiabatic. An analysis and experiment based on the electron analog of the AMC machine produced electron trajectories at low magnetic fields that predict the behaviour of high-energy protons in high magnetic fields. Experiments in the electron analog device verified charged-particle trajectories predicted by the computer. Author (TAB)

N68-28007*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

PROFILE MEASUREMENTS OF PLASMA COLUMNS USING MICROWAVE RESONANT CAVITIES

Michael A. W. Vlachos and Hulbert C. S. Hsuan May 1968 23 p refs

(Grant NGR-16-001-002)

(NASA-CR-95359; Rept.-68-30) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The density profile of a positive column of a gas discharge is measured by the comparison of two microwave cavity measurements. The two cavity modes used are the TE_{011} and TM_{020}. Author

N68-28074# United Kingdom Atomic Energy Authority, Culham (England).

PRESENT STATE OF RESEARCH ON PLASMA DIFFUSION IN MAGNETIC FIELDS

V. E. Golant Jan. 1968 37 p refs Transl. into ENGLISH from Russian Report 013

(NP-TR-1640; CTO-467)

A survey is given of experimental investigations of the transverse diffusion of charged plasma particles in a magnetic field. The experimental techniques used in determining the coefficient of diffusion in plasmas are reviewed and their limitations are analyzed. Methods based on measurements of transverse charged particle flux, of plasma lifetime, on investigations of the emission of plasma from a stationary source parallel to, and its propagation across, the magnetic field, and the analysis of the charged particle balance in the plasma are discussed. It is shown that the correct use of these techniques presents difficulties, so that it has often been difficult to obtain reliable quantitative data on the transverse diffusion of charged particles in a magnetic field. Some typical experiments designed to determine the diffusion coefficient in the simplest conditions are described, such as in a homogeneous magnetic field, or in the absence of a longitudinal current, of charged particle beams, or strong electric fields. Author (NSA)

N68-28095# United Kingdom Atomic Energy Authority, Culham (England). Translations Office.

PLASMA DIFFUSION IN A TOROIDAL STELLARATOR

A. A. Galeev, R. Z. Sagdeev, and G. P. Fyurs Feb. 1968 22 p refs Transl. into ENGLISH from Russian

(NP-TR-1644; CTO-489) CFSTI: HC $3.00/MF $0.65

The influence of weak toroidality of the system on the motion of particles trapped in regions of minimum B in a strong helical field is investigated. It is shown that the drift orbits of the trapped particles (known locally as "bananas") execute a slow motion in the toroidal magnetic field. The maximum deviation of the "bananas" from the magnetic surface during such a motion is determined by the geometry of the magnetic field and the value of the equilibrium electric field, but is independent of the Larmor radius of the particles. The plasma transport coefficients, associated with the distortion of the plasma due to the drift of the "bananas," are calculated. For a small inverse aspect ratio the transport coefficients are significantly smaller than Bohm's diffusion coefficient D_B. Thus, the coefficient of the ion thermal conductivity is $f_{Ti} < \epsilon_h t_{g_i}^2 D_B$, where $\epsilon_h < 1$ characterises the depth of modulation of the main field by the helical field. Author (NSA)

N68-28096# United Kingdom Atomic Energy Authority, Culham (England). Translations Office.

THE BUNCHING OF ELECTRONS IN A MAGNETIC TRAP

V. I. Volosov, V. E. Palchikov, and F. A. Tsalnik Feb. 1968 9 p refs Transl. into ENGLISH from Russian
(NP-TR-1648; CTO-490) CFSTI: HC $3.00/MF $0.65

The accumulation and containment of fast (up to 100 keV) electrons in a magnetic trap are investigated. The type of instability mainly observed during the experiment is related to the oscillatory motion of the electrons between the magnetic mirrors which limits the density of the "hot plasma." Certain characteristics of these oscillations are described, and a qualitative theory is put forward to explain the experimental results. Author (NSA)

N68-28136 Cornell Univ., Ithaca, N. Y.

OPTICAL EMISSION FROM A CHARGED PARTICLE SLOWING DOWN IN A PLASMA

Roger Leon Ptak (Ph.D. Thesis) 1966 63 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-1424

In this paper calculations are made for an alpha particle slowing in two types of plasma. The first plasma model consists of completely ionized H at $T = 10^5$°K. The second model has 90% H all ionized and 10% singly ionized He, with $T = 5 \times 10^4$°K. Total yields of various lines are calculated. We also get the line shape for the case of isotropic alpha particles and for the case of a beam of particles. An Fe particle is chosen as an example of a heavy ion, and estimates are obtained for total optical emission by the various ionization stages that are important as the Fe ion slows from 50 MeV to 1 MeV. It was found that the radiation yields are quite small. As the alpha particle goes from 10 MeV to thermalization, the total yield in the brightest visible line of He II is only about 10^{-4} eV for the first plasma model, and about 1 eV for the second model. The total yield in visible lines for Fe ion is about 100 eV. The intensity of the emission from an alpha particle with a velocity around 10^8 cm/sec or less is very sensitive to the plasma temperature, if kT is less than the excitation energy. A beam of such particles should thus prove useful as a plasma diagnostic tool. Dissert. Abstr.

N68-28154*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COAXIAL PLASMA GUN RESEARCH AT LEWIS RESEARCH CENTER

Charles J. Michels Washington Jul. 1968 15 p refs
(NASA-TM-X-1600) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Research on coaxial plasma guns in an effort to determine their potential for space propulsion applications was undertaken at the Lewis Research Center. The experimental parametric examination of various gun geometries, the theoretical analysis of capacitor-bank-variable-mass distribution gun systems, and the plasma diagnostics of various geometries are summarized. The results of this program indicated that the efficiency (≈40 percent) was too low to be competitive with alternative systems. Propellant, switching, and heat-rejection systems proved to be complicated. Author

N68-28171# Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research.

OBLIQUE COLLISIONLESS SHOCKS AND PLASMA TURBULENCE

Apr. 1968 15 p
(Contract AT(40-1)-3647)
(ORO-3647-2; PR-2) CFSTI: HC $3.00/MF $0.65

Experimental work has continued on the apparatus described earlier (ORO-3647-1) to study the structure of oblique shock waves in plasma. Concurrently, the computer code which predicts the shock structure on the basis of collisional transport coefficients has been developed to compare experiment and theory at each stage. The most significant results have been obtained by comparing shocks in hydrogen at 20 mtorr and in deuterium at 10 mtorr. These conditions produce plasmas of identical mass density and, therefore, identical dynamic behavior, but with different transport coefficients, since the ion–ion collisional mean free path in deuterium is eight times that in hydrogen. The results to date indicate that in the case of deuterium, collisional effects alone are not sufficient to account for the structure and that some collisionless interaction between the ions, giving rise to a reduced viscosity coefficient, is occurring. The cause of this anomalous viscosity is probably a streaming type of instability, but its precise nature remains to be identified. Author (NSA)

N68-28191# Stanford Univ., Calif. Linear Accelerator Center.

THE CHARGE DISTRIBUTION FUNCTION IN PERTURBATION THEORY OF CLASSICAL ELECTRODYNAMICS

E. L. Chu Jan. 1968 60 p refs
(Contract AT(04-3)-515)
(SLAC-83) CFSTI: HC $3.00/MF $0.65

In various problems of classical electrodynamics the solution is often found by solving the Boltzmann–Vlasov equation under proper constraints in six-dimensional phase space. A perturbation representation of the charge distribution function ψ is described in this paper. This representation is derived from the unperturbed distribution function ψ_0 by using a six-dimensional displacement vector ξ. It is shown that if ξ satisfied certain constraints, then $\psi = [\exp(-\overline{\nabla}\cdot\xi)]\psi_0$ satisfies the Boltzmann–Vlasov equation. The constraints which $\overline{\nabla}$ must satisfy are dictated by none other than the Lorentz equation of motion of a charged particle. This constitutes one proof of the equivalence between the Boltzmann–Vlasov equation and the Lorentz equation. This proof may have advantageous aspects, especially in connection with perturbation calculations. As an example, the work of Lee, Mills and Morton on multipole oscillations of a throbbing beam is discussed in detail. The salient features of different kinds of phase spaces are compared by considering simple relativistic particle systems. Author (NSA)

N68-28197# United Kingdom Atomic Energy Authority, Culham (England).

SOME CHARACTERISTICS OF THE PLASMA COLUMN IN TM-3 AT HIGH INITIAL HYDROGEN PRESSURES

G. A. Bobrovskii and K. A. Razumova Oct. 1967 11 p refs Transl. into ENGLISH from an IAE Rept.
(CTO-439; NP-TR-1618) CFSTI: HC $3.00/MF $0.65

In Tokamak TM-3, over a given range of operating conditions, the displacement of the equilibrium position of the plasma column relative to the center of the discharge vessel, departs from the theoretically predicted displacement, and possible causes are discussed. Author (NSA)

N68-28200# United Kingdom Atomic Energy Authority, Culham (England). Research Group.

PLASMA PRODUCTION IN A GAS JET BY MICROWAVE IONIZATION

J. Hugill Dec. 1967 16 p
(CLM-R-80) CFSTI: HC $3.00/MF $0.65

An experiment is described in which cold, neutral gas issuing from a nozzle is ionized by a 2400 MHz alternating electric field. In the steady state the electron temperature in argon is 3.4 eV, and ions are accelerated by electron pressure gradients near the nozzle. When the gas flow is pulsed the degree of ionization can be up to 2.9% and this does not represent the limit of the technique. Application to the filling of a closed magnetic trap is discussed. Author

N68-28210# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.

[ON CROSS-FIELD DIFFUSION IN CONFINED PLASMA COLUMN] Annual Progress Report

Kenneth C. Rogers and R. O. Motz Feb. 1968 17 p refs
(Contract AT(30-1)-2813)
(SIT-2813-44) CFSTI: HC$3.00/MF$0.65

The study of transverse diffusion in a single-ended potassium Q-device was completed. A new Q-device designed specifically for the generation of and optical studies on a barium Q-plasma is described. Theoretical studies on atomic and optical properties of the Ba+ ion are discussed. Experimental optical studies of a small prototype barium Q-plasma are also described briefly. NSA

N68-28289# California Univ., Livermore. Lawrence Radiation Lab.

FINITE β STABILIZATION OF ABSOLUTE LOSS CONE INSTABILITIES

L. D. Pearlstein 12 Mar. 1968 10 p refs
(Contract W-7405-ENG-48)
(UCRL-50397) CFSTI: HC$3.00/MF$0.65

The effect of finite β on absolute loss cone instabilities is calculated. It is shown that this addition tends to stabilize these modes. Limiting stable harmonics are presented for parameters in the thermonuclear regime. Author (NSA)

N68-28300# United Kingdom Atomic Energy Authority, Culham (England).

A METHOD FOR THE MICROWAVE HEATING OF PLASMA ELECTRONS

E. S. Hotston, J. M. Weaver, and D. J. H. Wort Jan. 1968 21 p refs
(CLM-R-78) CFSTI: HC$3.00/MF$0.65

This report suggests a new method of heating the electronic component of an arbitrarily dense, magnetized plasma. Examination of the Appleton–Hartree equation reveals the existence of a wave which propagates in the plasma and is subject both to strong collisional absorption and Landau damping, and which could thus be used to heat plasma electrons. The wave may be launched by coupling from a microwave slow wave structure outside the plasma, although the launching efficiency is poor if a conventional TM (transverse magnetic) structure is used. If a TE structure can be developed, the coupling to the plasma would be greatly improved. A free space treatment of the coupling is supported by an alternative treatment which regards plasma and slow wave structure as an integrated whole; this allows a rigorous analysis of the effect of the plasma boundaries and permits the inclusion of nonuniform plasma, but cannot give the efficiency of the coupling between structure and plasma. It is concluded that provided an efficient TE slow wave structure can be developed, a plasma electron heating method of wide application has been found. Author

N68-28302# Westinghouse Research Labs., Pittsburgh, Pa. Advanced Plasma Concepts.

PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER Final Report, 1 Feb. 1967–31 Jan. 1968

A. G. Engelhardt, T. V. George, H. Hora, and J. L. Pack 7 Mar. 1968 59 p refs
(Contract AT(30-1)-3472)
(WERL-3472-9) CFSTI: HC$3.00/MF$0.65

The focused output beam of a Q-switched ruby laser having a power of 150 MW and a total energy of 3 joules has produced plasmas from isolated single aluminum spheres 50 to 150 μ in radius. Before being struck successfully, each target was positioned in the vacuum system by an electromagnetically operated retracting pedestal system. In the present pedestal design the diameter of the obstacle-free region can be as large as 21 cm. The technique can be extended to larger ultrahigh vacuum systems. Between 30 and 50% of the incident laser energy was absorbed by the plasma. Framing camera pictures taken at times up to 0.9 μsec show two luminous shells: an inner spherically symmetric core and an outer ring expanding more rapidly and slightly asymmetrically back toward the laser. The behavior of the outer shell, which contained ions having energies up to 5 keV and less than 1% of the plasma, is consistent with a theoretical model based on the nonlinear collisionless interaction of laser light with inhomogeneous plasma. The behavior of the inner core, which contained almost all of the plasma, is consistent with a thermodynamic equilibrium theory. For a target 50 μ in radius, the outermost ions of this core has an energy of 500 eV. The average energy of the core ions, decreased from 200 eV/Al atom for a 50-μ target to 20 eV/Al atom for a 120 μ target. Studies using a 70-GHz microwave interferometer show that the expansion velocity of the cutoff density front was 5×10^6 cm-sec^{-1} between 0.2 and 0.8 μsec in agreement with theory and that the average electron density decreased from 1.4×10^{11} cm^{-3} at 4 μsec to 6×10^{10} cm^{-3} at 6 μsec. Author (NSA)

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N68-26995# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

GENERAL REGULARITIES OF FORMATION OF CRYSTAL STRUCTURES OF ELEMENTS DEPENDING ON ELECTRON STRUCTURE OF ATOMS

V. M. Karashchuk 14 Jul. 1967 52 p refs Transl. into ENGLISH from Tr. Inst. Inzh. Zheleznodorozhnogo Transp. (Moscow), no. 165, 1963 p 16–51
(FTD-MT-65-583; AD-668925)

A table is given showing the dependence of crystalline structures of elements on the number of electrons in the incompleted electronic subshells of its atoms. The conclusion is drawn that the types of crystalline structures of the elements depend on the configuration of the outer electronic subshells acquired by the atoms prior to crystallization. Crystalline structures of elements not governed by the 8 - N rule are determined by one or both external electronic subshells that are crystallographically most active and by the number of electrons they possess at the time the atoms crystallize. Elements governed by the 8 - N rule form valence molecular crystals with the participation of allowed s- and p-levels, which are crystallographically most active. Author (TAB)

N68-27031# Oak Ridge National Lab., Tenn.

SOLID STATE DIVISION ANNUAL PROGRESS REPORT, PERIOD ENDING DECEMBER 31, 1967

D. S. Billington and M. K. Wilkinson Mar. 1968 130 p refs
(Contract W-7405-ENG-26)
(ORNL-4250) CFSTI: HC$3.00/MF$0.65

Brief summaries of work on projects in the following fields are presented: lattice dyanmics, magnetic properties, electron spin resonance, electronic and optical properties, low-temperature properties, radiation damage, channeling, dislocations and radiation effects on plastic deformation and fracture, surface studies and anomalous X-ray transmission, research materials, and experimental facilities. Many of the summaries are abstracts of papers published, to be published, or presented at meetings. A list of publications is included. NSA

N68-27082# Norwegian Inst. of Tech., Trondheim. Electrical Engineering Dept.

THEORETICAL INVESTIGATION OF BULK SEMICONDUCTOR TECHNIQUES FOR APPLICATION TO PHASED ARRAY MICROWAVE DEVICES Progress Report, 1 Jan.–31 Dec. 1967

Tore Wessel-Berg 31 Dec. 1967 46 p refs
(Contract AF 61(052)-907)
(RADC-TR-68-210; AD-669137)

The objectives of the contract are: to conduct a predominantly theoretical investigation of bulk semiconductor techniques with a view towards development of devices applicable to phased array microwave devices. The following topics have been investigated during the report period: (1) Wave propagation studies in semiconductors. (2) Coupled-mode instabilities. (3) Current instabilities in non-uniform semiconductors. The research progress within these areas is reported in the present progress report. Author (TAB)

N68-27096# Wesleyan Univ., Middletown, Conn. Scott Lab. for Physics.

ENERGY OF ELECTRONS EXTRACTED FROM SOLIDS BY HIGH ELECTRIC FIELDS Final Report, Oct. 1964–Sep. 1967

Allan M. Russell Sep. 1967 7 p refs
(Contract Nonr-4676(01))
(AD-668625)

Contents: Electron trajectories in a field emission microscope; Harmonic analysis in system using phase sensitive detectors; Tables of non-relativistic electron trajectories for field emission cathodes; Direct measurement of the energy of electrons obtained from the surface of silicon by field emission; Field emission spectrometer; Observation of the band gap in the energy distribution of electrons obtained from silicon by field emission; Use of a water aspirator in conjunction with sorption pumping on an ultrahigh vacuum system; Electron optical properties of a field emission cathode. TAB

N68-27123 California Univ., Berkeley.

BAND STRUCTURE AND OPTICAL PROPERTIES OF SEMICONDUCTORS AND INSULATORS

Thomas Karl Bergstresser (Ph.D. Thesis) 1966 132 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8525

Pseudopotential form factors and band structures are determined for eighteen semiconductors and insulators of the diamond and zinc-blende structures: AlSb, C, CdTe, GaAs, GaP, GaSb, Ge, InAs, InP, InSb, Si, Sn, ZnS, ZnSe and ZnTe, and of the wurtzite structure: CdS, CdSe and ZnS. The form factors appear to be accurate to 0.01 Ry and yield energy bands which agree with experiment to within ≈0.01 Ry near the band gap and ≈0.04 Ry over a range of 1 Ry. For some of these substances these are the first band structures to be calculated. For the cubic-structure materials, experimental values of the splitting of energy levels in the crystal are used. The form factors determined for cubic ZnS are used to calculate the band structure of the hexagonal, wurtzite form. This aids in the investigation of the relation of the band structures of these two forms. The hexagonal band structure is used to interpret the optical data, confirming some previous identifications, causing some new interpretations, and explaining previously unidentified structure. Dissert. Abstr.

N68-27140 California Univ., Berkeley.

TUNNELING INTO SUPERCONDUCTORS IN A MAGNETIC FIELD

Jerry Millstein (Ph.D. Thesis) 1966 60 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8611

Tunneling experiments were performed on thin superconducting films in the presence of a magnetic field. The experiments were done at He^3 temperatures on tin and tin–indium alloy films with thicknesses between 600 and 2000 Å. The effect of the field on the density of states is, for dirty films, similar to the effect of paramagnetic impurities. The square of the magnetic field plays a role analogous to the paramagnetic impurity concentration. The data are compared to the results of Scalski et al., and agreement is fair. The difference between their results and this experiment is attributed to mean free path effects. Wyder and Strassler have calculated the field dependence of the density of states for films with arbitrary mean free path. We find that their calculations are in good agreement with experiment. Dissert. Abstr.

N68-27156 Cornell Univ., Ithaca, N. Y.

LOW ENERGY GOLD ION BOMBARDMENT OF GOLD

Larry Edward Thomas (Ph.D. Thesis) 1966 86 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-1433

The point defect aggregates produced in metal foils by bombardment with low energy ions are thought to be particularly simple, consisting of interstitial atoms which are produced about 100 Å beneath the foil surface, at the ends of focused replacement collision sequences which start from the bombarded surface. The bombarding ions and any vacancies are believed to remain at the bombarded surface. Thus, low energy ion bombardment is of interest for investigating the mobility behavior of such interstitials in the absence of vacancies. In the present work the formation of interstitial atom clusters by the aggregation of interstitial point defects, and the shrinkage of vacancy aggregates (stacking fault tetrahedra) as a result of annihilation by the interstitial point defects, were studied in 270 eV gold ion bombarded gold using transmission electron microscopy in order to determine the temperature range where interstitials become mobile in gold. Some bombardments were also carried out with 190 and 270 eV argon ions. Dissert. Abstr.

N68-27177# American Optical Co., Southbridge, Mass. Research Div.

ESR AND OPTICAL ABSORPTION STUDIES OF TRANSITION METAL IONS AND COLOR CENTERS IN GLASS Semiannual Technical Report, 1 Apr.–30 Sep. 1967

Robert J. Landry and Joseph T. Fournier Mar. 1968 32 p refs
(Contract N00014-67-C-0186; ARPA Order 306; Proj. Defender)
(TR-599-2; SATR-2; AD-668997)

The program of study of the transition metal ions in glass was concerned with a study of the Cr(3+) ion in glass. Experiments to measure the magnitude of the zero field splitting parameter /2D/ of isolated Cr(3+) ions in glass were undertaken. Attempts to measure the magnitude of the isotropic exchange coupling constant /J/ for antiferromagnetically coupled Cr(3+) ion pairs in glass were successfully undertaken and a preliminary J value was obtained. The anisotropic terms which give rise to zero field splittings of the Spin multiplets for this system are considered. Experimentally, from the frequency dependence of the ESR spectrum for this system, it was possible to obtain an estimate of the zero field splitting of the S = 1 level. The experimental color center defect studies in laser glass includes investigations of both permanent and transient color centers. A description of a theoretical investigation of trapped hole centers in glass is also given. TAB

N68-27199# Atomic Energy Commission, Washington, D. C.

SUPERCONDUCTIVITY PROGRAM OF THE ATOMIC ENERGY COMMISSION

B. W. Birmingham Jun. 1967 90 p refs
(WASH-1081) GPO: $0.55

Current activities in the field of superconductivity are discussed, primarily because of programs in high-energy physics and controlled

thermonuclear research. The technical and economic benefits to many of the programs are also discussed and suggestions made for future emphasis of the research and development program. It is clear that superconducting dc magnets, using the new high-field materials, offer not only economic gains, but may also make possible experiments that have previously either been technologically impossible or economically not feasible. Superconducting resonant cavities will make continuous operation of linear accelerators possible, and the advancements in cryogenic technology that are sure to result from this application will also make possible the efficient cooling of long coaxial lines for electric signal and power transmission. The application of superconducting devices to synchrotron-type accelerators, storage rings, and accelerator experimental areas needs much more research and study, but the present qualitative understanding of the possible benefits suggests that a substantial effort on these matters would be justified. Finally, the relationship of the AEC laboratories and the industry working on superconducting materials and devices is discussed. It is suggested that a transition phase in superconducting technology is ending and that perhaps there sould be a reorientation of the AEC laboratory role to be consistent with public policy. Such a reorientation, involving industry more extensively, should bring about a much more rapid exploitation of superconducting technology along with the associated economic and programmatic benefits.
Author (NSA)

N68-27212# Brown Univ., Providence, R. I.

A STUDY OF ELECTRON RADIATION DAMAGE IN GaAs, GaP GaAs$_{1-x}$P$_x$ BASED ON RECOMBINATION RADIATION Interim Technical Report

R. M. Esposito Wright-Patterson AFB, Ohio ARL Jan. 1968 163 p refs
(Contract AF 33(615)-2310)
(ARL-68-0021; AD-668547)

The results of a study of electron bombardment induced radiation damage in GaAs, GaP and GaAs(1-x)P(x) single crystal based on monitoring the recombination radiation (cathodoluminescence spectrum) of these materials is presented. The electrons which produced the damage were supplied by a 450 Kev Van De Graaff accelerator. Irradiations were performed at liquid nitrogen or liquid helium temperatures. The temperature dependence of the cathodoluminescence spectrum was established in N- and P-GaAs. The changes in the spectra resulting from exposure to electrons of sufficient energy to cause atomic displacements consisted only of reductions in the intensity of all lines in the pre-irradiation spectra, i.e. no new lines or bands associated with radiative transitions involving the centers introduced by the irradiation were found in any of the materials. The thresholds for damage, i.e. the minimum electron energy needed to bring about a detectable change in the intensity of emission under constant excitation conditions were determined. The degradation rates as a function of electron energy were compared to the Mott-Mckinley-Feshbach formulation and were generally found to give good qualitative agreement. An estimate of the capture cross sections of the radiation defects was made.
Author (TAB)

N68-27217 California Univ., Berkeley.

PARTICLE SIZE EFFECTS IN NUCLEAR MAGNETIC RESONANCE ON SUPERCONDUCTORS

Fulton Watkins Wright, Jr. (Ph.D. Thesis) 1966 59 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8675

The Knight shift in the superconducting state has been observed in samples containing various sizes of small tin particles. The three main samples were constructed by vacuum evaporation of alternate layers of metal and dielectric (silicon monoxide). The fractions of the normal state shift (referred to α tin) remaining at zero temperature were 84, 74, 62 percent respectively. The data fit well the theory of spin-reversing scattering through spin-orbit coupling which had been proposed to explain the finite Knight shift in superconductors. Two other possible contributions, a shift due to Van Vleck type orbital susceptibility and crystalline field spin-orbit coupling, cannot be ruled out theoretically but do not appear important experimentally.
Dissert. Abstr.

N68-27276# Naval Ordnance Lab., White Oak, Md.

DEPENDENCE OF THE TRANSPORT PROPERTIES OF TRANSITION METAL ALLOYS AND COMPOUNDS ON THE ELECTRON NUMBERS

J. F. Goff *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 7 p refs (See N68-27267 16-17)

A comparison of the transport properties of the elements, compounds, and alloys of the first long period shows many similarities if the electron number is taken as a parameter, although the substances may differ magnetically. This result suggests that their transport band structures are similar. A model for the dependence on electron number of this band structure is deduced from the transport properties of some of the nonmagnetic compounds. It is suggested that the model applies to the magnetic substances when they are in their magnetically ordered state.
Author

N68-27277# National Bureau of Standards, Washington, D. C.

LINE PROFILES IN THE NUCLEAR MAGNETIC RESONANCE AND MOSSBAUER EFFECT OF TITANIUM IRON COBALT ALLOYS

L. J. Swartzendruber and L. H. Bennett *In* NOL Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 20 p refs (See N68-27276 16-17)

The ^{57}Fe Mössbauer effect (ME) and the ^{59}Co nuclear magnetic resonance (NMR) were investigated as a function of alloy concentration, temperature and stoichiometry in TiFe$_{1-x}$Co$_x$ alloys over most of the range $0 \leq x \leq 1$. At room temperature, in carefully prepared samples, a single ^{57}Fe ME line was observed for all values of x. This line broadened somewhat at low temperatures although the magnetic properties of these alloys would have led one to expect a larger broadening at certain compositions. The ^{59}Co NMR line width was narrowest for x close to 0 or 1 and was a strong function of x as well as of temperature and magnetic field. The intermediate compositions displayed resolved satellite structures. Annealing reduced both the ME and NMR linewidths. Deviations from stoichiometry and internal oxidation were readily observable from their effect on the ME line profile. Comparisons are made with TiFe$_2$ and stainless steel ME spectra. Both the ME and NMR results for TiFe$_{1-x}$Co$_x$ are consistent with a CsCl structure over the entire composition range. The NMR results indicate a lack of atomic ordering on the Co–Fe sublattice.
Author

N68-27279# Naval Ordnance Lab., White Oak, Md.

ANALYSIS OF THE HALL COEFFICIENT BEHAVIOR IN TITANIUM IRON, TITANIUM COBALT, TITANIUM NICKEL, AND THEIR ALLOYS

R. S. Allgaier *In its* Symp. on TiNi and Assoc. Compds. 20 Feb. 1968 6 p (See N68-27267 16-17)

Band structure calculations are used to explain the Hall coefficient behavior in titanium-iron, titanium-cobalt, titanium-nickel, and their alloys. The analysis is based on Mattheiss's calculation for nonmagnetic bcc, Cr, Mo, and W. In the vicinity of six valence electrons per atom, the theory indicates four pieces, or sets of equivalent pieces, of the Fermi surface can be present: (1) an electron jack, (2) a hole octahedron, (3) six hole ellipsoids, and (4) six electron ellipsoids.
B.S.D.

N68-27318# Stanford Univ., Calif. Solid-State Electronics Lab.

THE ELECTRICAL AND METALLURGICAL PROPERTIES OF DEFECTS IN COMPOUND SEMICONDUCTORS Technical Summary Report, 1 Sep. 1963–31 Jan. 1968

G. L. Pearson and J. F. Gibbons Feb. 1968 25 p refs
(Contract DA-31-124-ARO(D)-155)
(SU-SEL-68-020; AROD-2895.26-E; AD-668930)

The report summarizes a program directed toward the following seven separate projects related to the electrical and metallurgical properties of defects in compound semiconductors: (1) diffusion, solubility, and distribution coefficient of zinc in gallium arsenide and gallium phosphide; (2) analytical study of zinc diffusion in gallium arsenide and the electrical properties of the resulting diffused layers; (3) electron microprobe study of lattice point defects in semiconductor single crystals; (4) a point contact method for determining the charge carrier density and mobility in thin semiconducting layers; (5) some effects of gamma radiation on silicon and silicon devices; (6) green electroluminescence at p-n junctions in gallium phosphide; (7) fundamental studies on the properties of the Ga(x)Al(1-x)As system. TAB

N68-27324 Cornell Univ., Ithaca, N. Y.

A STUDY OF SURFACE SELF-DIFFUSION AND SURFACE ENERGY IN NICKEL

Subraya P. Maiya (Ph.D. Thesis) 1966 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-1478

A mass transfer method which is based on the interferometric observation of the relaxation of sinusoidal profiles has been applied to investigate surface self-diffusion and surface energy in nickel. A photoetching technique has been developed for producing sinusoidal shapes on single crystal surfaces and the relaxation of these surfaces has been studied under high vacuum conditions. Surface energies of nearly planar (100) and (110) surfaces have been estimated from the measured volume diffusion contribution to surface smoothing. These values have been used in studying the variation of surface diffusion coefficients with temperature, surface orientation and direction on certain low index planes of nickel. The results obey the equation $D_s = D_o \exp(-Qs/kT)$. The anisotropy of D_s observed on the low index planes studied in this work has been found to be small. At any given temperature, D_s on different planes vary by less than a factor of 2. There is no directional dependence of D_s on the (100) plane. It is shown that surface energy or other independent information on the bonding of surface atoms should be included if these models are to be applicable to surface duffusion. Dissert. Abstr.

N68-27326# Massachusetts Inst. of Tech., Cambridge.

RESEARCH IN MATERIALS SCIENCE AND ENGINEERING Annual Report, 1967–1968

Apr. 1968 395 p refs
(AR-7; AD-668215)

Summaries are given of current research projects at MIT in the following areas: Chemical and solid state physics; electric, magnetic, and optical properties and applications to devices; metallurgy and materials science; materials engineering. Special sections are devoted to reviews of work at the Francis Bitter National Magnet Laboratory, Instrumentation Laboratory, Solid State Division of Lincoln Laboratory, and Central Facilities of the Interdisciplinary Laboratory. TAB

N68-27329# Pennsylvania State Univ., University Park. Materials Research Lab.

RELATION OF MECHANICAL PROPERTIES TO THE STRUCTURE OF IONIC SOLIDS Quarterly Report, 1 Dec. 1967–28 Feb. 1968

K. Vedam and R. E. Newnham Watertown, Mass. Army Mater. and Mech. Res. Center 20 Mar. 1968 41 p refs
(Contract DA-19-066-AMC-325(X))
(AMMRC-CR-66-07/7; QR-7; AD-668722)

Bending experiments on micas confirm the existence of nonlinear stress-strain relationship in these ionic crystals. The crystal structure of synthetic 1M-BaLiMg2AlSi3O10F2 mica was refined by least squares and Fourier methods to an R-factor of 7.1% in space group C 2/m. There is no ordering of lithium and magnesium in the two octahedral sites. The structures of fluorophlogopite and barium mica were compared and the differences analyzed in terms of local charge imbalance, the valency of the interlayer cation and decreased cation-cation repulsion in the octahedral sheet. The physical properties of these micas and others are analyzed in terms of their structural features. Author (TAB)

N68-27348# Stanford Research Inst., Menlo Park, Calif.

DIFFUSION AND HETEROGENEOUS REACTION 12. DIFFUSION COEFFICIENT MEASUREMENTS OF ATOMIC OXYGEN THROUGH VARIOUS GASES

Robert S. Yolles and Henry Wise Nov. 1967 26 p refs
(Contracts N00014-67-A-0226-0005; Nonr-3623(00); Proj. Squid)
(SRI-26-P; AD-669118)

Steady-state and time-transient measurements of the decay of oxygen atoms in a cylinder with catalytic walls have been used to determine the diffusion coefficient of atomic oxygen in O2, He, Ar, and Kr. The relative change in atom density as a function of distance (under steady-state conditions) and time (after the atom source is shut off) was followed by observing the luminescence associated with the reaction of oxygen atoms with nitric oxide. The diffusion coefficients at 298K and 1 atm were found to be: D(O-O2) = 0.27; D(O-He) = 0.73; D(O-Ar) = 0.39; D(O-Kr) = 0.16 (sq. cm)/sec. Author (TAB)

N68-27389*# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.

EFFECT OF FLUORINE AND OXYGEN ON THE WORK FUNCTION OF POLYCRYSTALLINE TUNGSTEN

J. G. Bergman and R. E. Stickney [1967] 6 p refs Presented at the 26th Ann. Conf. on Phys. Electron., Cambridge, Mass., 20–22 Mar. 1966
(Grant NGR-22-009-091)
(NASA-CR-85160) CFSTI: HC$3.00/MF$0.65 CSCL 20L

To identify some of the problems and anomalous effects that may be associated with fluorine additives, experiments were conducted to determine the dependence of the work function of tungsten on F_2 pressure and on emitter temperature; to measure the desorption energy of F_2 on tungsten; and to compare these data for F_2 with corresponding data obtained for O_2. The experimental apparatus is described, along with the techniques used for the thermionic emission and contact potential measurements. The preliminary results indicate that F_2 does desorb completely from tungsten at temperatures below 2600°K. M.G.J.

N68-27393# Lincoln Lab., Mass. Inst. of Tech., Lexington.

SOLID STATE RESEARCH, 1 NOVEMBER 1967–31 JANUARY 1968

Alan H. Mc Whorter 12 Apr. 1968 68 p refs *its* No. 1
(Contract AF 19(628)-5167)
(ESD-TR-68-17; AD-668762)

In this program a feasibility study was conducted of a conductive cooling system for cooling a man in space. In the concept studied the cooling was provided by a porous plate sublimator and controlled by a variable thermal conductance layer. The results of the tests performed demonstrate the need for advances in technology and further development work to make this concept feasible. Author (TAB)

N68-27439*# Illinois Univ., Urbana. Dept. of Physics.

RECOMBINATION LIFETIMES IN GAMMA-IRRADIATED P-TYPE FLOAT ZONE SILICON

Ralph A. Hawes and W. Dale Compton [1966] 29 p refs
Presented at the Intern. Conf. Phys. of Semicond., Tokyo, Sep. 1966
(Grant NsG-228-62)
(NASA-CR-82348) CFSTI: HC$3.00/MF$0.65 CSCL 20L

Much research has been done in recent years on the defects introduced into silicon by irradiation. Hall effect, photoconductivity and infrared absorption, and spin resonance measurements, along with lifetime studies, have now been performed on electron and gamma-irradiated materials, n- and p-type, crucible grown and floating zone grown. Knowledge of the defects controlling recombination is of particular interest, since many important processes in semiconductor devices are controlled by the minority carrier lifetime. When the recombination levels coincide with the major defect levels, as appears to be the case in n-type silicon, lifetime measurements yield the values of the capture cross sections. When the recombination is controlled by defects which are not easily, if at all, detected by other techniques, lifetime measurements may be the only means of obtaining information about these defects. This appears to be the case for at least some of the recombination defects in p-type floating zone grown silicon. Author

N68-27442*# Rice Univ., Houston, Tex.

DIRECT ONE-PHONON SPIN-LATTICE RELAXATION TIMES FOR ND3+ AND U3+ IONS IN CAF$_2$ IN SITES OF TETRAGONAL SYMMETRY

P. L. Donoho and T. D. Black [1965] 13 p refs Presented at the 14th Colloq. Ampere, Ljubljana, Yugoslavia
(Grant NsG-6)
(NASA-CR-77664) CFSTI: HC$3.00/MF$0.65 CSCL 20L

By utilizing the spin-lattice Hamiltonian measured by Black and Donoho for U^{3+} and Nd^{3+} ions in sites of tetragonal symmetry in CaF_2 we have calculated the direct one-phonon spin-lattice relaxation times for these ions at low temperatures and microwave frequencies. Although fair agreement with experimental values is obtained for U^{3+} ions, the calculations yield values as much as a factor of 10^5 larger than the experimental values for Nd^{3+} ions. This disagreement is surprising in view of the fact that the same method of computation leads to very good agreement with experiment in the case of the iron-group ions. The possibility of other mechanisms of relaxation than the Van Vleck direct mechanism is considered in this paper. Author

N68-27463# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Avionics Lab.

A PARAMETRIC STUDY OF THIN FILMS OF TANTALUM-NITROGEN COMPOUNDS

E. A. Buvinger Feb. 1968 13 p refs
(AFAL-TR-67-345; AD-669053)

Thin films of tantalum-nitrogen compounds were deposited by reactive sputtering onto quartz substrates for electrical and optical measurements and onto carbon-coated grids for electron diffraction analysis using hot- and cold-stage techniques. The films were deposited at substrate temperatures varying from room temperature to 500C at sputtering voltages varying from 1 to 5 kV. The relationship between nitrogen content and lattice structure is presented and compared with resistivity and optical absorption measurements. Author (TAB)

N68-27469*# Stanford Univ., Calif. Dept. of Physics.

EXCITON-MAGNON EFFECTS IN THE OPTICAL SPECTRUM OF MnF$_2$

R. L. Greene, D. D. Sell, and R. M. White (Calif. Univ., Berkeley) [1966] 21 p refs Presented at the Conf. on the Opt. Properties of Ions in Crystals, Baltimore, 12–14 Sep. 1966 Submitted for publication
(Grant NsG-331)
(NASA-CR-78453) CFSTI: HC$3.00/MF$0.65 CSCL 20L

The optical properties of magnetic materials have been studied with renewed interest during the past year. This has been due, in part, to the identification of exciton-magnon absorption, (spin wave sidebands), in the visible spectrum of MnF_2, and two magnon absorption in the infrared spectrum of FeF_2. In this paper we discuss some of the visible absorption and fluorescence properties of antiferromagnetic MnF_2. Our experiments indicate that the absorption spectrum is an intrinsic property of the pure crystal, whereas the fluorescence is caused by impurities. Therefore, we consider these separately. We treat the absorption in terms of excitons and magnons. From the symmetry of the excitons and magnons, group theoretical selection rules can be found for the magnon sidebands. An explicit treatment of the interaction yields the same selection rules and shows that the exciton and magnon are generated on opposite sublattices. The emission is discussed from a single-ion view-point. A simple model is discussed which describes the general properties of the emission spectrum. In this case it is found that the sidebands result from an excited state and magnon on the same sublattice. Author

N68-27621 Rensselaer Polytechnic Inst., Troy, N. Y.

IONIZATION EFFECTS IN BULK SILICON

John Norton Park (Ph.D. Thesis) 1966 102 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9294

Electrical breakdown phenomena have been studied in near-intrinsic silicon at room temperature and in nickel-doped π silicon at 77°K. Devices prepared with ohmic contacts on near-intrinsic (undoped) silicon exhibit a linear current-voltage relationship to a field of about 10^4 volts per cm, followed by a non-ohmic region in which the current increases at a greater rate than the voltage. At a critical value of field (the threshold field) a sudden transition through a negative resistance region to a state of low voltage (the sustaining voltage) and high current occurs. The current in the new state is essentially limited by the source resistance. Devices prepared with blocking contacts on near-intrinsic (undoped) silicon exhibit blocking behavior to a field of about 1.3×10^4 volts per cm. The current-voltage characteristics for nickel-doped π material at 77°K shows two linear states separated by sharp discontinuties. This breakdown phenomenon is thought to be due to impact ionization of holes from neutral and singly-ionized nickel atoms. Calculations are made to substantiate this reasoning. A theory of impact ionization is developed for the double acceptor system displayed by nickel in silicon. Dissert. Abstr.

N68-27639*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PROTON DAMAGE TO SILICON AS A FUNCTION OF PROTON ENERGY

Roger A. Breckenridge and Chris Gross [1967] 15 p refs Presented at the 45th Ann. Meeting of the Va. Acad. of Sci., Norfolk, Va., 3–6 May 1967
(NASA-TM-X-60124) CFSTI: HC$3.00/MF$0.65 CSCL 20L

It is important for NASA to be able to predict the amount of damage produced in silicon electronic devices by the high energy protons which are present in space. To accomplish this, the dependence of the proton damage on the energies of the incident protons must be known. It was the purpose of the experiments reported in this paper to provide this information. The energy dependence of the majority carrier removal rates in n- and p-type silicon single crystals for the energy range from 10.7 MeV to 53.25 MeV has been established by means of the determination of the Hall coefficient of the silicon. The results that have been obtained are directly applicable to majority carrier devices such as the junction field-effect transistor. Author

N68-27670 Johns Hopkins Univ., Baltimore, Md.

THERMO ELECTRIC CYCLOTRON RESONANCE IN SEMICONDUCTORS

Peter David Fisher (Ph.D. Thesis) 1967 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-9568

A novel method for observing cyclotron resonance in semiconductors has been predicted and observed experimentally. It can be viewed as a Seebeck voltage induced by cyclotron heating of the free carriers in a spatially inhomogeneous microwave electric field. An expression for this induced voltage has been derived for nondegenerate n-type germanium. The momentum equation was solved yielding an expression for the average energy gained by an electron in crossed oscillating electric and static magnetic fields. By means of the theory of the equipartition of the energy, this increase in the average electron energy was expressed in terms of an increase in the average electron temperature. The Boltzmann transport equation was solved under the assumption of electron temperature gradients across the sample. With this perturbed distribution function, an expression for the short circuit "thermo-electric-cyclotron-resonance" (TECR) current was obtained. Dissert. Abstr.

N68-27746*# Illinois Univ., Urbana. Dept. of Physics.

RECOMBINATION LUMINESCENCE IN N-TYPE CZOCHRALSKI SILICON

Robert J. Spry and W. Dale Compton [1966] 16 p refs
Presented at the Intern. Conf. on the Phys. of Semicond., Tokyo, Sep. 1966
(Grant NsG-228-62)
(NASA-CR-82347) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The present work was undertaken with the view of comparing the nature of the luminescence introduced by both Co^{60} and fast neutron irradiations, and to determine the influence of the nature and amount of dopant, both intentionally added impurities and accidental impurities, such as oxygen, upon the luminescence spectra, and to extend the temperature range of measurements to lower temperatures where thermal effects would become less important. The results of these measurements on Czochralski grown n-type materials are presented. Author

N68-27788 Purdue Univ., Lafayette, Ind.

AN INVESTIGATION OF THE INTERFACE STATES OF THE GERMANIUM SILICON ALLOYED HETEROJUNCTION

Arthur Leonard Reenstra (Ph.D. Thesis) 1967 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-10243

The heterojunction interface is studied to more conclusively determine if interface states exist due to dislocations, or if an impurity contamination exists at the interface. Since a perfect match of lattice constants is normally not possible in heterojunctions, defects, mainly in the form of interfacial dislocations, may be present at the heterojunction interface. The experimental results from the measurements of electrical properties of isolated bulk dislocations, grain boundary dislocations and dangling bonds at surfaces, as well as at $Si\text{-}SiO_2$ interfaces, suggest that the defects at the interface of heterojunctions may produce important effects. A profile of the mixing of the silicon and germanium in an alloyed Ge-Si heterojunction is determined for the alloyed heterojunction by employing an electron microprobe. In n-n type heterojunctions, a p-type layer is observed by measuring the V-I characteristics. Capacitance of the p-n junction to the bulk germanium materials is measured to determine the carrier concentration in the p-layer and, in conjunction with the Hall coefficient, the width of the p-layer. From the electrical measurements and the electron microprobe analysis, there is very strong evidence to show the energy gap at the interface to be caused by dislocations. These measurements rule out the two sources of impurities as a cause of the interface states and show direct evidence of dislocations causing the interface states. Dissert. Abstr.

N68-27830 Princeton Univ., N. J.

CONDUCTANCE IN TUNNEL METAL INSULATOR SEMICONDUCTOR STRUCTURES

Albert S. Waxman (Ph.D. Thesis) 1967 232 p
Available from Univ. Microfilms: HC $10.60/MF $3.00 Order No. 67-9615

Quantum Mechanical tunneling through thin insulating barriers has received considerable attention in recent years, especially in metal-insulator-metal structures and in semi-conductor p-n junctions. However, very little work has been done on tunneling in the metal-insulator-semiconductor system, although the MIS structure is one in which much work has been done. The research has mostly been on "thick" insulators, where the tunnel current is negligible. The purpose of this work is to report on an analytic and experimental study of tunneling in MIS contacts. (In all of the work to be discussed, the insulator barrier is considered high enough so that over the barrier thermal currents can be neglected). The possible dc and ac currents which can flow are defined, and the question of carrier statistics in the semiconductor analyzed. Dissert. Abstr.

N68-28023# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).

THE RECOVERY OF STRUCTURAL DEFECTS IN REFRACTORY BCC METALS AFTER IRRADIATION AND AFTER COLD WORK: A LITERATURE SURVEY

J. Nihoul and L. Stals [1967] 18 p refs
(BLG-424; CONF-670718-2)

A review is given of the recovery of structural defects in the body-centered-cubic metals tungsten, molybdenum, tantalum, and niobium. Special attention is paid to the recovery stages as found by means of electrical resistivity measurements following fast-particle irradiation and following plastic deformation. Author (NSA)

N68-28034*# Autonetics, Anaheim, Calif.

INVESTIGATION OF SINGLE-CRYSTAL FERRITE THIN FILM

J. E. Mee, E. C. Whitcomb, and L. Kolb Jun. 1968 33 p refs
(Contract NAS12-522)
(NASA-CR-86063; C8-1241/501) CFSTI: HC $3.00/MF $0.65 CSCL 20B

It is the objective of this program to grow and characterize epitaxial lithium ferrite films. The growth method is chemical vapor deposition (CVD). It was predicted from chemical thermodynamic arguments that lithium halides would be considerably less reactive than iron halides in the proposed deposition reactions. Experimental evaluation of candidate source materials confirmed this prediction and indicated that lithium iodide, LiI, and iron (III) chloride, $FeCl_2$, would be compatible source materials. Reactor conditions were established using these source materials and epitaxial ferrite deposits were obtained on MgO substrates. These deposits had Fe:Li weight ratios ranging from 120:1 to values within experimental error of the desired 40.3:1 ratio. In normal deposition runs, there was a repeatable zone-type behavior in which high Fe:Li deposits were formed first in the reactor and deposits with successively lower Fe:Li ratios were formed "downstream." The deposits were not smooth on [100] and [110] MgO substrates. This appeared to be due to a preferred growth direction which could be resolved by depositing on [111] substrates. Author

N68-28036# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

A CRYSTALLOGRAPHIC AND SPECTROSCOPIC STUDY OF CRYSTAL SITES IN THE "SPINEL" STRUCTURE [ETUDE CHRISTALLOGRAPHIQUE ET SPECTROSCOPIQUE DES SITES CRISTALLINS DANS LA STRUCTURE "SPINELLE"]

Maurice Drifford (Ph.D. Thesis—Paris Univ.) 1967 149 p refs
In FRENCH
(CEA-R-3356)

A crystallographic study on magnesium aluminates led to the determination of crystal site average distortion. A spectroscopic study of transition-element-doped spinels gave the position of the doping element in tetrahedral (A) or octahedral (B) sites, and the local distortion of the latter. The comparison of average and local parameters points to differences in the behavior of doping elements and shows the size of (A) sites are independent of the host-crystal composition while the average size of (B) sites varies with the composition. Author (NSA)

N68-28148# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.

DETS: A COMPUTER PROGRAM FOR CALCULATING THE EFFECTIVE TEMPERATURE FOR A CRYSTALLINE SOLID

Marilyn M. Sowden and A. S. Johnston 7 Sep. 1967 73 p refs
(WANL-TME-1666) CFSTI: HC$3.00/MF$0.65

DETS is a program which calculates the values of the specific heat, the Debye–Waller factor, the average energy per mode, the DEBYE temperature for each of these three cases, and the effective temperature. It was written for the CDC-6600 computer in FORTRAN IV. The specific heat, Debye–Waller factor, and average energy per mode are calculated from the normal mode frequency distribution of a crystal lattice. The three corresponding Debye temperatures are obtained by iteration on the upper limit of the integrals from the corresponding Debye model formulas. The effective temperature is obtained from the Debye model using a Debye temperature. Author (NSA)

N68-28187# Department of Supply, Melbourne (Australia). Aeronautical Research Labs.

A STUDY OF STRAIN HARDENING IN COPPER SINGLE CRYSTALS

S. Mk. Cousland Sep. 1966 62 p refs
(ARL/MET-61)

Copper single crystals of many orientations have been strained in tension at a wide variety of temperatures. Measured values of parameters characterising the stress-strain curves of single crystals are in good agreement with the results of other workers. In addition, experiments involving controlled changes of temperature show that the flow stress of any strain-hardened state is linearly dependent on the temperature of measurement in the temperature range 77°K to 443°K at least, and probably down to 4.2°K. Thus the flow stress τ_0 at 0°K can be computed after measuring the flow stress change resulting from a temperature change between two known temperatures. The Cottrell–Stokes ratio—a parameter expressing the temperature sensitivity of the flow stress—has been computed for a large number of crystals strained under many different conditions. Author

N68-28194*# Rice Univ., Houston, Tex.

RESEARCH ON THE PHYSICS OF SOLID MATERIALS Semiannual Status Report, 1 May–31 Oct. 1967

F. R. Brotzen, H. E. Rorschach, and M. L. Rudee 31 Oct. 1967 33 p refs
(Grant NsG-6-59)
(NASA-CR-95358; SASR-17) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Summaries are presented for research activities related to defect structure and mechanical behavior of solid materials, their electrical and optical properties, magnetism and superconductivity, thermodynamics and solid surfaces, and thin film properties. Both basic and applied studies were undertaken and competence of students and staff was increased through interdisciplinary cooperation in fields related to solids and seminar program. M.W.R.

N68-28239*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

LOW-TEMPERATURE RESISTANCE IN MINIMUM AND MAGNETORESISTANCE FOR DILUTE ALLOYS OF IRON IN COPPER

John S. Loomis and Wayne R. Hudson Washington Jul. 1968 12 p refs
(NASA-TN-D-4626) CFSTI: HC$3.00/MF$0.65 CSCL 20L

A temperature dependence of the Fe–Cu resistivity was compared with the predictions of Kondo and Nagaoka. The Nagaoka theory fits the experimental results better than the Kondo theory. The transverse magnetoresistance was measured as a function of temperature and magnetic field. For concentrations less than 0.03 at. % Fe in Cu, the magnetoresistance was positive and was approximately linear for higher magnetic fields. For Fe concentrations greater than 0.03 at. %, the magnetoresistance became increasingly negative with increasing concentrations. The magnetoresistance of the 0.073-at. %-Fe sample fit a magnetic field dependency of H 1.33. Author

N68-28297# United Kingdom Atomic Energy Authority, Harwell (England). Solid State Physics Div.

NEUTRON MONOCHROMATOR STUDIES AT A.E.R.E.

K. C. Turberfield Feb. 1968 35 p refs
(AERE-R-5647) CFSTI: HC$3.00/MF$0.65

The work described has been undertaken to observe and improve the characteristics of certain single crystals for use as Bragg reflecting neutron monochromators. Crystals normally available have micromosaic widths that are inadequate to take full advantage of the intensities available using normally accepted resolution widths. Mosaic widths of up to 30'-to 40' have been achieved in copper crystals by doping with beryllium and up to 12' in germanium by distortion at high temperatures. Observation of integrated reflectivities R_θ and mosiac widths η (f.w.h.ht.) of these and other monochromator crystals at wavelengths from 1 to 2Å show that the peak reflectivities (approx. R_θ/η) are largely independent of η and of the crystal material used within a factor of about two. Author

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N68-28994# Naval Air Propulsion Test Center, Philadelphia, Pa. Aeronautical Engine Dept.

INVESTIGATION OF TURBINE FUEL FLAMMABILITY WITHIN AIRCRAFT FUEL TANKS Final Report

L. J. Nestor Washington FAA Jul. 1967 63 p refs
(FAA Order FA65-NF-AP-2)
(DS-67-7; AD-669001)

The equilibrium flammability envelopes of turbine fuels were determined by both visual and instrumental techniques. The lean and rich limits were found to be linear functions of altitude and temperature when wall effects were reduced and ignition spark energies were high. The linearity of the limits could be altered by increasing the wall effects or decreasing the ignition spark energies. Wide-cut turbine engine fuels, aviation kerosenes and blends of the two types were tested. The flammability characteristics of the fuels at equilibrium were compared to those of the fuel under simulated aircraft dynamic conditions. Aircraft dynamics affect fuel primarily by producing spray. When the point of ignition was not directly within the sprayed fuel, no deviation from the normal equilibrium flammability envelope occurred. When the point of ignition was directly within the spray, the lean flammability limit of the fuel was extended considerably beyond the equilibrium limit. Author (TAB)

N68-27242*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ANALYSIS OF PROPELLANT SLOSH DYNAMICS AND GENERATION OF AN EQUIVALENT MECHANICAL MODEL FOR USE IN PRELIMINARY VOYAGER AUTOPILOT DESIGN STUDIES
Thomas A. Lance 1 Dec. 1966 62 p refs
(Contract NAS7-100)
(NASA-CR-95147; JPL-TM-33-306) CFSTI: HC $3.00/MF $0.65 CSCL 21I

The linearized dynamic equations of propellant motion in the regime dominated by gravity force have been developed for a cylindrical tank approximation of the Lunar Excursion Module Descent Propulsion System (LEMDS) propellant tanks. An equivalent mechanical model consisting of a fixed mass and an infinite series of springs and masses has been generated. A computer program has been developed to calculate the parameters required to describe the equivalent mechanical model for an assumed spacecraft flying an assumed mission profile. These parameters are presented as a function of time for three mission profiles and can be used for preliminary analysis of Voyager closed-loop autopilot designs. Transfer functions for the propellant dynamics are also presented. Author

N68-27850# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF APPRAISING THERMAL STABILITY OF FUELS UNDER DYNAMIC CONDITIONS
1 May 1967 154 p refs Transl. into ENGLISH of the book "Metody Otsenki Ekspluatatsionnykh Svoystv Reaktivnykh Toplin i Smazochnykh Materialov" Moscow, Izd. Mashinostr., 1966 p 1–131
(FTD-MT-66-99; AD-668115)

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2. METHOD OF APPRAISING THE BURNING CHARACTERISTICS OF HYDROCARBON FUELS IN A CHAMBER TYPE BURNER L. D. Gogitidze, V. V. Makarenkov, G. M. Panchenkov, O. G. Pustyrev, and V. V. Yakovlevskiy p 13–21 refs (See N68-27852 16-27)

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4. METHOD OF APPRAISING THERMAL STABILITY OF FUELS UNDER DYNAMIC CONDITIONS M. Ye. Tararyshkin and B. D. Zaloga p 35–41 (See N68-27854 16-27)

5. DETERMINING THERMAL STABILITY OF FUELS IN A ROCKING AUTOCLAVE M. P. Alekseyeva and K. I. Ivanov p 43–46 ref (See N68-27855 16-27)

6. DETERMINING THE PRESSURE OF SATURATED HYDROCARBON FUEL VAPOR M. Ye. Tararyshkin and O. M. Chechkina p 47–53 refs (See N68-27856 16-27)

7. DETERMINING THE VOLATILITY OF HYDROCARBON FUELS AT LOW PRESSURES M. Ye. Tararyshkin p 55–59 (See N68-27857 16-27)

8. DETERMINING THE PRESSURE OF SATURATED VAPORS OF FUELS ON A DIAPHRAGM INSTRUMENT M. Ye. Tararyshkin and O. M. Chechkina p 61–68 refs (See N68-27858 16-27)

9. METHODS OF APPRAISING FUEL LOSSES DUE TO EVAPORATION IN AIRCRAFT TANKS P. A. Rybakov and M. Ye. Tararyshkin p 69–85 refs (See N68-27859 16-27)

10. DETERMINING NONSTATIONARY SOLUBILITY OF GAS IN HYDROCARBON FUELS L. D. Gogitidze, V. P. Logvinyuk, V. V. Makarenkov, V. V. Malyshev, G. M. Panchenkov et al p 87–94 refs (See N68-27860 16-27)

11. INSTRUMENT FOR DETERMINING THE QUANTITY OF GAS DISSOLVED IN A LIQUID V. D. Borisov, L. D. Gogitidze, V. P. Logvinyuk, V. V. Makarenkov, V. V. Malyshev et al p 95–97 (See N68-27861 16-27)

12. A METHOD OF APPRAISING THE THERMOOXIDIZING STABILITY OF AVIATION OILS AT RAISED TEMPERATURES L. V. Starikova, G. S. Bleyes, and Ye. T. Kruglov p 99–103 ref (See N68-27862 16-15)

13. DETERMINING THERMAL STABILITY OF LUBRICATING GREASES A. R. Kosyakin and Ye. A. Uspenskaya p 105–110 (See N68-27863 16-15)

14. METHOD OF APPRAISING THE LUBRICATING ABILITY OF HIGH-TEMPERATURE LUBRICANTS IN A WIDE RANGE OF TEMPERATURES L. A. Mayorova p 111–117 refs (See N68-27864 16-15)

15. APPRAISING THE EFFICIENCY OF GREASE LUBRICANTS IN BALL BEARINGS A. R. Kosyakin, Ye. A. Uspenskaya, and Ye. V. Iskusnykh p 119–126 refs (See N68-27865 16-15)

16. METHODS OF DETERMINING THE TEMPERATURE OF SELF-IGNITION OF OILS G. I. Yudina and V. N. Khaylova p 127–131 refs (See N68-27866 16-15)

N68-27851# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF APPRAISING JET PROPELLANTS IN A SMALL COMBUSTION CHAMBER OF A TURBOJET ENGINE (TRD) [METOD OTSENKI REAKTIVNYKH TOPLIV NA MALORAZMERNOY KAMERE SGORANIYA TRD]
Ye. R. Tereshchenko, B. D. Zaloga, and S. M. Maksimov *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 1 May 1967 p 3–12 refs (See N68-27850 16-27)

The possibility of evaluating fuels on small single combustion chamber laboratory equipment was investigated. Tests were run on B-70 aviation gas, on diesel, T-2, TS-1 and T-1 fuels and kerosene for fuel start-up characteristics, limits of stable combustion, completeness of combustion and carbon deposition. The laboratory method is sufficiently accurate for practical purposes. Test values are in agreement with those obtained on full size turbojet engine combustion chambers. The laboratory method is recommended for evaluating new fuels and also for testing standard fuels prepared from new crudes or by changed technology. Author

N68-27852# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF APPRAISING THE BURNING CHARACTERISTICS OF HYDROCARBON FUELS IN A CHAMBER TYPE BURNER [METOD OTSENKI KHARAKTERISTIK GORENIYA UGLEVODORODNYKH TOPLIV NA GORELKE KAMERNOGO TIPA]
L. D. Gogitidze, V. V. Makarenkov, G. M. Panchenkov, O. G. Pustyrev, and V. V. Yakovlevskiy *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 13–21 refs (See N68-27850 16-27)

A testing burner of the diffusion chamber type and the testing procedures are described. Characteristics obtained with the app. agreed qual. with those obtained directly in a combustion chamber of a reactive motor. With the proposed burner and 150–200-ml. fuel samples the errors in parallel detns. of the completeness of burning were 2.0–2.5%. Author

N68-27853# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHODS OF APPRAISING THERMAL STABILITY OF JET FUELS [METODY OTSENKI TERMICHESKOY STABIL'NOSTI REAKTIVNYKH TOPLIV]
Ye. R. Tereshchenko *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 23–33 refs (See N68-27850 16-27)

The thermal stability of reactive fuels and methods of determining it are discussed and an apparatus for evaluating thermal stability under static conditions is described. Evaluation of the thermal stability of fuels gives an indication of the inclination of the fuel to form tars and insoluble residues. Apparatus TSRT-1 is recommended for thermal stability determinations of new fuels in the wide temperature range of 100–250°C, while apparatus TSRT-2 is recommended for thermal stability determinations of new and standard reactive fuels at 150°C. Author

N68-27854# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF APPRAISING THERMAL STABILITY OF FUELS UNDER DYNAMIC CONDITIONS [METOD OTSENKI TERMICHESKOY STABIL'NOSTI TOPLIV V DINAMICHESKIKH USLOVIYAKH]
M. Ye. Tararyshkin and B. D. Zaloga *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 35–41 (See N68-27850 16-27)

The method for evaluating the thermal stability of fuels comprises injecting the fuel heated to the desired temperature through a filter simulating the operation of the fuel filter of an engine. Measurement of the pressure drop through the filter as its pores become plugged with deposits of insolubles formed by thermal decomposition of the fuel gives an accurate determination of the thermal stability of the fuel. A fuel causing no essential pressure drop after 5 hours in the test equipment is considered heat stable. Corrosiveness of the fuel is determined by change in weight of metal strips immersed in the heated fuel for a given time. Method-confirming tests were run with standard fuels T-1 and TS-1 and with T-1 purified by H_2SO_4 treatment and T-1 with deposit-preventing additives. Author

N68-27855# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINING THERMAL STABILITY OF FUELS IN A ROCKING AUTOCLAVE [OPREDELENIYE TERMICHESKOY STABIL'NOSTI TOPLIV V KACHAYUSHCHEMSYA AVTOKLAVE]
M. P. Alekseyeva and K. I. Ivanov *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 1 May 1967 p 43–46 ref (See N68-27850 16-27)

The effect of movement on the values of the heat stability indices of reactive fuels was studied in the laboratory utilizing a rocking autoclave to simulate the motion of fuel in tanks. Tests run on T-1 and T-5 fuels and on fuels containing cracked products showed that the thermo-oxidative processes in motionless and in agitated fuels do not differ too significantly–there is little effect on deposit and resin formation and acidity is just noticeably higher.

N68-27856# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINING THE PRESSURE OF SATURATED HYDROCARBON FUEL VAPOR [OPREDELENIYE DAVLENIYA NASYSHCHENNOGO PARA UGLEVODORODNYKH TOPLIV]
M. Ye. Tararyshkin and O. M. Chechkina *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 1 May 1967 p 47–53 refs (See N68-27850 16-27)

A tensimeter was adapted for use in determining vapor pressure of saturated hydrocarbon fuels. This modified tensimetric method was found to be sufficiently accurate at maximum vapor pressures not exceeding 2 kg/sq cm. The deviation among determinations also exceeds 2% when the vapor pressures are very low (at temperatures below 20°C). Author

N68-27857# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINING THE VOLATILITY OF HYDROCARBON FUELS AT LOW PRESSURES [OPREDELENIYE ISPARYAYEMOSTI UGLEVODORODNYKH TOPLIV PRI NIZKIKH DAVLENIYAKH]
M. Ye. Tararyshkin *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 1 May 1967 p 55–59 (See N68-27850 16-27)

A laboratory method was worked out for evaluating the volatility of fuels at 200–250°C at pressures below atmospheric. Essentially the weight of the fuel evaporated from the sample into a special container is determined under the given test conditions as shown. It was verified that the method is applicable to fuels of different fractional compositions–T01, TS-1 and naphtha fractions. Author

N68-27858# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINING THE PRESSURE OF SATURATED VAPORS OF FUELS ON A DIAPHRAGM INSTRUMENT [OPREDELENIYE DAVLENIYA NASYSHCHENNYKH PAROV TOPLIV NA MEMBRANNOM PRIBORE]
M. Ye. Tararyshkin and O. M. Chechkina *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 21 May 1967 p 61–68 refs (See N68-27850 16-27)

A steel apparatus with a metallic membrane for measuring pressure was adapted for use with hydrocarbon fuels of complex chemical composition. It was found that the membrane apparatus is sufficiently accurate for determining the pressure of saturated fuel vapors in the wide temperature range from 20 to 350–400°C. Reproducibility of results was satisfactory. Pressure of vapors of degassed and of non-degassed fuel samples can be measured. The pressure of the saturated fuel vapor increased when air was dissolved in the fuel. Author

N68-27859# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHODS OF APPRAISING FUEL LOSSES DUE TO EVAPORATION IN AIRCRAFT TANKS [METODY OTSENKI POTER'TOPLIVA OT ISPARENIYA V VAKAKH SAMOLETOV]
P. A. Rybakov and M. Ye. Tararyshkin *In its* Method of Appraising Thermal Stability of Fuels Under Dyn. Conditions 1 May 1967 p 69–85 refs (See N68-27850 16-27)

Evaluation of various laboratory methods as well as of calculation methods for determining fuel losses due to evaporation in the tanks of aircraft is presented. Tests showed that errors in fuel loss determinations on laboratory apparatus employing vibration of fuel and on equipment simulating the fuel system of aircraft do not exceed ±1.2% (absolute difference). More complete evaluation can be conducted in the simulative equipment, but it does require a larger amount of fuel and dry ice. The same small degree of error was encountered in determining fuel loss from evaporation during flight in comparing samples of fuels taken from the aircraft tanks before and after flight. Based on experimental data, a nomograph was constructed for determining fuel losses based on actual pressure of saturated fuel vapors before flight and pressure in the tanks during flight. The absolute error of determinations according to the nomograph also does not exceed ±1.2%. Author

N68-27860# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DETERMINING NONSTATIONARY SOLUBILITY OF GAS IN HYDROCARBON FUELS [OPREDELENIYE NESTATSIONARNOY RASTVORIMOSTI GAZA V UGLEVODORODNYKH TOPLIVAKH]

L. D. Gogitidze, V. P. Logvinyuk, V. V. Makarenkov, V. V. Malyshev, G. M. Panchenkov et al *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 1 May 1967 p 87–94 refs (See N68-27850 16-27)

A simple method was worked out and equipment was designed for determining the solubility and the diffusion coefficient of a gas in liquid under nonstationary conditions. This involves direct measurement of the volume of gas dissolved in the liquid. Conditions approximate those in the wing tanks of heavy subsonic aircraft. Equations given for calculating the nonstationary solubility of gas in a liquid enable one to calculate the gas concentration according to the depth of the fuel layer and to calculate the total amount of dissolved gas at any time. Author

N68-27861# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INSTRUMENT FOR DETERMINING THE QUANTITY OF GAS DISSOLVED IN A LIQUID [PRIBOR DLYA OPREDELENIYA KOLICHESTVA GAZA; RASTVORENNOGO VZHIDKOSTI]

V. D. Borisov, L. D. Gogitidze, V. P. Logvinyuk, V. V. Makarenkov, V. V. Malyshev et al *In its* Method of Appraising Thermal Stability of Fuels under Dyn. Conditions 1 May 1967 p 95–97 (See N68-27850 16-27)

A simple apparatus for determining the amount of gas dissolved in a liquid was designed so that it could be used as a gas pipette for VTI, Orsat or other gas analyzers. A special feature of the apparatus is the use of an elastic membrane to equalize the pressure between the measuring burette and the surrounding space, and measurement of the volume of liberated gases at different pressures and temperatures. A deviation of 3.5% was found in the measurement of gases separated from a hydrocarbon fuel. Water and other liquids may be used in the determinations. Author

N68-28166*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE BOILOFF PROBLEM WITH METHANE FUEL IN SUPERSONIC AIRCRAFT

Richard J. Weber Washington Jul. 1968 15 p refs
(NASA-TM-X-1604) CFSTI: HC$3.00/MF$0.65 CSCL 21D

The benefits of employing methane fuel in supersonic aircraft are lessened by the tendency of the cryogenic fuel to boil away in flight. Boiloff due to ambient pressure reduction during climb appears to be the most difficult to avoid. Subcooling the fuel and using a soluble pressurant such as air or nitrogen is evaluated. Another solution is zero-ullage storage. Alternatively, it is suggested that the boiloff penalties with nonsubcooled fuel may be acceptable. In the study airplane gross weight is allowed to vary as required to yield the desired range and payload. Author

N68-28179# Deutsche Versuchsanstalt fur Luft und Raumfahrt, Stuttgart (West Germany). Institut fuer Raketentreibstoffe.

THEORETICAL PERFORMANCE OF F_2/H_2-ROCKET PROPELLANT COMBINATIONS USING GASEOUS COMPONENTS AT AMBIENT TEMPERATURE [THEORETISCHE LEISTUNGEN DER RAKETENTREIBSTOFFKOMBINATION F_2/H_2 BEI VERWENDUNG GASFOERMIGER KOMPONENTEN VON ZIMMERTEMPERATUR]

Roger Edwin Lo Apr. 1968 17 p ref In GERMAN; ENGLISH summary
(DLR-Mitt.-68-08; DVL-720) CFSTI: HC$3.00/MF$0.65

Theoretical values of specific impulse of the combination of gaseous fluorine with gaseous hydrogen have been calculated for mixture ratios between 0.1 and 1.2 mols of fluorine per mol H_2. Temperature and constitution of combustion gases in chamber, throat, and end of nozzle (at 10:1 and 10:0.01 kp/cm^2 expansion) are plotted against mixture ratio. Author

N68-28214# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany).

THEORETICAL PERFORMANCE OF THE HYBRID ROCKET PROPELLANT COMBINATION F_2/LIH [THEORETISCHE LEISTUNGEN DER LITHERGOLEN RAKETENTREIBSTOFF-KOMBINATION F2/LIH]

R. E. Lo Apr. 1968 17 p refs In GERMAN; ENGLISH summary
(DLR-Mitt.-68-07) CFSTI: HC $3.00/MF $0.65

Theoretical values of specific impulse have been calculated for mixture ratios ranging from 0.2 to 2 mols of fluorine per mol LiH. Temperature and constitution of combustion gases in chamber, throat and end of nozzle (at 10:1 and 10:0.01 kp/cm^2 expansion) are plotted against mixture ratio. Author

N68-28305# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany).

SOME PROPERTIES OF LITHIUM HYDRIDE WITH RESPECT TO ITS USE AS A ROCKET FUEL. PART 2: HEAT CONDUCTIVITY OF LIH-FUEL BLOCKS [EINIGE EIGENSCHAFTEN VON LITHIUMHYDRID IM HINBLICK AUF SEINE VERWENDUNG ALS RAKETENBRENNSTOFF. 2. TEIL: WAERMELEITFAEHIGKEIT VON LIH-PRESSOERPERN]

R. E. Lo Apr. 1968 18 p refs In GERMAN; ENGLISH summary
(DLR-FB-68-23; DVL-722) CFSTI: HC$3.00/MF$0.65

Heat conductivity of cylindrical LiH fuel grains with densities between 0.56 and 0.7 g/cm^3 has been measured in the temperature range of approximately 50° to 500°C. In this range the heat conductivity was found varying between 1.1 and 4.0 kcal m^{-1} h^{-1} °C^{-1}, increasing with increasing temperature and increasing density. The apparatus used is described. Author

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N68-26981*# Giannini Scientific Corp., Santa Ana, Calif. Special Projects Group.

DESIGN AND DEVELOPMENT OF A THERMO-IONIC ELECTRIC THRUSTOR Final Report, 30 Apr. 1964–11 Jan. 1968

A. C. Ducati, R. G. Jahn, E. Meuhlberger, and R. P. Treat May 1966 402 p refs
(Contract NASw-968)
(NASA-CR-54703; FR-056-968) CFSTI: HC $3.00/MF $0.65 CSCL 21C

An experimental and theoretical investigation of propulsion performance and basic physical processes of thermo-ionic electric thrustors has been conducted. Fifty hour continuous operation has been achieved with H_2 at 3000, 6000 and 10,000 seconds with very little degradation in performance. The results of these tests have yielded extensive information on life properties. Efficiencies have been measured over a wide range of arc parameters. One of the significant results was the very weak dependence of efficiency on magnetic field strength in the 1 to 16 kilogauss range. For sufficiently high mass flows the thrust efficiencies of H_2 and D_2 follow the frozen flow efficiencies over a wide range of specific impulse. The thermal efficiency was above 60 percent for optimum operating conditions. Thermal efficiencies of various other propellants were considerably lower. A study of the effect of the test environment on performance has been initiated. The goal of this investigation is the definition, and possibly the construction, of a test environment that would permit a reliable extrapolation of terrestrial tests to deep space conditions. The distribution of arc currents has been studied theoretically in some detail. Energy transfer by ohmic heating and energy equipartition have been investigated. The transfer of energy from electrons to heavy particles by collisions appears to be effective under some conditions. Elementary aspects of a continuum model of an axisymmetric, fully ionized, rotational flow in a strong magnetic field have been considered. Author

N68-26987*# Hughes Research Labs., Malibu, Calif.
LIQUID MERCURY CATHODE ELECTRON BOMBARDMENT ION THRUSTERS Summary Report, 1 Aug. 1964–31 Oct. 1966
W. O. Eckhardt, H. J. King, J. A. Snyder, J. W. Ward, G. Hagen et al 31 Oct. 1966 111 p refs
(Contract NAS3-6262)
(NASA-CR-54674) CFSTI: HC $3.00/MF $0.65 CSCL 21C

The LM cathode invented as a solution to the cathode life problem of electron bombardment ion thrusters has been developed from a crude laboratory device to a highly efficient and reliable unit. (The LM cathode is basically a gravity-independent, force-fed version of the mercury pool cathode used in mercury rectifiers and other discharge tubes.) Furthermore, the LM cathode has been integrated successfully into complete Kaufman-type thrusters, and the cathode durability has been demonstrated by a life test which has exceeded 5250 hours, with over 4000 hours of in-thruster operation. An ion source efficiency of 75% at a specific impulse of 6400 sec (67% at 3400 sec) was reliably attained. Automatic startup and closed loop operation have been demonstrated during the last 1000 hours of the life test with a prototype mercury feed system which is suitable for use in a flight-type propulsion system. For the last 500 hour test increment the thruster was also equipped with an LM cathode neutralizer. Life results showed: (1) no cathode degradation after >5250 hours of operation; (2) absolute stability of thruster characteristics over >4000 hours of test duration; (3) extrapolated accelerator lifetime of >10,000 hours; (4) complete insensitivity of thruster and cathode to intermittent operation and exposure to air (even by catastrophic vacuum failure); and (5) demonstration of 85% mass utilization at a power expenditure of 393 eV/Hg ion. On the basis of these results it is concluded that thruster systems based on the LEM cathode are competitive with any present electric propulsive system and attractive for actual space missions. Author

N68-27107# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF THE FORM OF TURBINE CHARACTERISTIC ON ITS AVERAGE EFFICIENCY IN THE PRESENCE OF A PULSATING GAS FLOW [VLIYANIYE FORMY KHARAKTERISTIKI TURBINY NA YEYE SREDNIY K.P.D. PRI PUL'SIRUYUSHCHEM POTOKE GAZA]
Ye. I. Sukhov 29 Sep. 1967 14 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb Zaved., Mashinostro. (Moscow), no. 7, 1965 p 110–117
(FTD-MT-67-60; AD-668515)

The effects of turbine characteristics on the average efficiency during pulsating gas flow were theoretically investigated. Since second order approximations of turbine characteristics are not accurate in most cases, a third order approximation was assumed. Author (TAB)

N68-27196# Southwest Research Inst., San Antonio, Tex.
EFFECTIVENESS OF AN INERTIAL AIR CLEANER IN EXTENDING GAS TURBINE LIFE IN A DUSTY ENVIRONMENT Final Technical Report
Gary E. Thomas Mar. 1968 58 p refs
(Contract DAAK02-68-C-0007)
(AR-643; AD-668258)

Two 60 kw gas turbine driven generator sets were operated simultaneously at rated load in a controlled dusty environment. One of the units was protected with an inertial type air cleaner; the other was unprotected. The objective of the test was to provide a basis for determining the level of air inlet protection required for small general purpose military gas turbine engines. The investigation demonstrated that useful life of a gas turbine can be significantly extended with the application of a commercially available inertial type air cleaner and that turbine parts can be severely damaged by small concentrations of dust particles less than 10 - 20 microns in size. It also appears possible that some life improvement can be achieved through materials selection for certain components. Author (TAB)

N68-27334*# TRW, Inc., Cleveland, Ohio.
IMPROVED THROAT INSERTS FOR ABLATIVE THRUST CHAMBERS
D. N. Crump, H. H. Henderson, and K. J. Smith Sep. 1967 308 p refs
(Contract NAS3-6280)
(NASA-CR-54984; TRW-ER-6130-16) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Information contained in this report summarizes work performed on a NASA LeRC program aimed at achieving greater durability for throat inserts in highly oxidizing environments. Discussions are presented on materials oxidation performance and developments in overcoming thermal shock characteristics of oxide and carbide materials through both material composite development and unique design constructions. Design construction for four unique concepts and the performance they achieve in a N_2O_4-50% UDMH 50% N_2H_4 environment at 100 psi pressure are presented. Notable successes include exposure times in excess of 1250 seconds in uncooled pulsed and sustained burst (300 seconds) tests with zero throat erosion in combination hard throat ablative chamber constructions. Author

N68-27410*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ANALYSIS OF FREQUENCY RESPONSE CHARACTERISTICS OF PROPELLANT VAPORIZATION
Marcus F. Heidmann and Paul R. Wieber Washington 1966 33 p refs Presented at 2d Propulsion Joint Specialist Conf. sponsored by AIAA, Colorado Springs, Colo., 13–17 Jun. 1966
(NASA-TM-X-52195) CFSTI: HC $3.00/MF $0.65 CSCL 21B

The dynamic response of a droplet vaporization process excited by traveling transverse acoustic oscillations is derived by linear analysis. Results of a previous nonlinear numerical study used to formulate the analytical model are reviewed, and a transfer function representative of the dynamics of the vaporization process is derived. The analysis provides dimensionless parameters related to propellant physical properties that characterize the dynamic behavior of the vaporization process. Application is made to the vaporization of heptane, oxygen, fluorine, ammonia, and hydrazine. The dynamic response of these propellants attains a peak value at a particular frequency. A comparison is made with a burning-rate process designed by a characteristic time and an interaction index giving similar behavior. Author

N68-27443*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF INCREASED INLET GUIDE VANE ROTOR SPACING ON COMPRESSOR NOISE REDUCTION

W. Latham Copeland and John L. Crigler [1967] 15 p refs Presented at the 72d Meeting of the Acoust. Soc. of Am., Los Angeles, 2–5 Nov. 1966
(NASA-TM-X-59214) CFSTI: HC$3.00/MF$0.65 CSCL 21E

The inlet guide vanes of a turbojet engine in the 2000 pound thrust range were relocated forward about six chord lengths with the objective of reducing noise. Comparisons are made of the noise characteristics of the simply modified engine with those of the basic engine. The compressor noise levels for the modified engine are shown to be greatly reduced for all frequencies, with no measurable performance loss. Author

N68-27691 Duke Univ., Durham, N. C.

TRANSIENT SUBSONIC VISCOUS FLOW IN THE VACUUM AIR PROPULSION SYSTEM

Jai Raj Narain Rajan (Ph.D. Thesis) 1967 228 p
Available from Univ. Microfilms: HC $10.35/MF $3.00 Order No. 67-9757

The Vacuum-Air Propulsion system consists of a partially evacuated tube in which a closely fitting vehicle is propelled by the pressure difference of partial vacuum on one side and atmospheric air at higher pressure on the other side. A general discussion and historic development of this and related systems, as well as review of pertinent previous research is initially presented. A nonsteady analysis of this system, which includes the losses due to viscous friction, inertial and acceleration effects besides other losses, has been developed. This analysis consists in the simultaneous solution of the equation of motion of the projectile and construction of the characteristic net. The entire wave diagram analysis is carried out on the digital computer. This enables the inclusion of the various losses in the analysis without making major simplifying assumptions. Dissert. Abstr.

N68-27741*# Hughes Research Labs., Malibu, Calif.

HIGH-TEMPERATURE LM CATHODE ION THRUSTERS

Quarterly Progress Report, 5 Feb.–4 May 1968

J. Hyman, Jr., W. O. Eckhardt, J. W. Pfeifer, and J. A. Snyder 15 May 1968 49 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952131)
(NASA-CR-95262; QPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 21C

A 20-cm electron-bombardment thruster using an LM cathode was operated at a beam current $I_S = 550$ mA with a total source energy per ion $V_S = 250$ eV/ion at a mass utilization of 85% (V_S includes all power required to form the ions, since no vaporizer, cathode heater, or keeper power is required with the LM cathode). Measurements of Poiseuille flow of liquid mercury through a single-capillary stainless steel tube (0.0076 cm dia.) were linear and repeatable with pressure to within the experimental error of ±5% over the range 20–75 psia. A single-capillary flow impedance has been fabricated and is undergoing testing with a specially designed LM cathode. This combination may be capable of very high uniformity in the mercury flow rate. A new LM cathode has been fabricated which utilizes a linear-slit pool-keeping structure. LM cathode neutralizer development concentrated on establishing the limits of performance with copper as the permanently wettable metal (used to stabilize the position of the liquid surface) and comparing the performance of other materials. A thermally integrated 30-cm diameter permanent-magnet thruster has been designed which has a calculated weight of approximately 4.7 kg. Author

N68-28112*# Bendix Corp., Southfield, Mich. Research Labs.

RESEARCH AND DEVELOPMENT OF A VORTEX VALVE FOR FLOW MODULATION OF A 16-PERCENT ALUMINIZED 5500°F PROPELLANT GAS

T. W. Keranen and A. Blatter Washington NASA Jun. 1968 137 p refs
(Contract NAS1-5199)
(NASA-CR-1091; Rept.-4227) CFSTI: HC $3.00/MF $0.65 CSCL 13K

The flow of hot (5500°F) gas from a solid propellant gas generator has been successfully throttled by a fluidic, no-moving-part, vortex valve. The vortex valve has been demonstrated in a system simulating a hot gas secondary injection thrust vector control (SITVC) system. The hot gas vortex valves were controlled by a pilot stage utilizing a flapper-nozzle and vortex amplifier valve arrangement which modulated the flow of a 2000°F pilot stage solid propellant gas generator. Materials found suitable for the 5500°F hot gas application consist of silver-infiltrated tungsten, carbon or silica phenolic and solid carbon. The development effort consisted of six hot gas firings which demonstrated satisfactory material selection, hot gas flow modulation, and steady-state and dynamic performance of a simulated SITVC system. Author

N68-28261*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

STRESS ANALYSIS OF SOLID PROPELLANT ROCKET MOTORS

F. A. Akyuz and E. Heer 1 Jul. 1968 28 p refs
(Contract NAS7-100)
(NASA-CR-95372; JPL-TR-32-1253) CFSTI: HC $3.00/MF $0.65 CSCL 21H

A brief description of problems in the stress analysis of solid propellant rocket motors is given with a short review of related recent literature. The general linear viscoelastic and elastic problem, some possible means of solution, and the hypotheses and assumptions involved are discussed. A brief account of the computer program ELAS for elastic analyses is given. Solutions of typical two- and three-dimensional problems are presented and compared with those obtained by others. The effect of Poisson's ratio close to 0.5 on the computed results has been evaluated and is discussed. Possible future developments of the numerical methods of analysis in connection with available theories and analytical works are outlined. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N68-28986*# Rice Univ., Houston, Tex. Dept. of Space Science.

SATELLITE AND ROCKET OBSERVATIONS IN THE AURORAL ZONE

Bernt N. Maehlum [1967] 33 p refs Presented at the Birkeland Symp., Sandefjord, Norway, Sep. 1967
(Contract NAS5-1061; Grant NsG-673)
(NASA-CR-88068) CFSTI: HC$3.00/MF$0.65 CSCL 04A

A brief survey of the particle climate in the auroral zone is followed by an analysis of variations in particle energy spectra and pitch angle distributions during individual days. Evaluated are rocket and satellite observational data and their relationships to auroral luminosity, upper atmosphere ionization, etc. Results show that during quiet nights, electron fluxes are more isotropically distributed over large latitude intervals and that the fluxes of precipitating electrons are highest in the morning. G.G.

N68-27178# Washington Univ., Seattle. Cosmic Ray Lab.

[BASIC RESEARCH IN THE AREA OF COSMIC RAY AND PARTICLE PHYSICS] Final Report, 1 Sep. 1967–31 Aug. 1967

J. J. Lord 17 Apr. 1968 8 p refs
(Contract Nonr-477(12))
(AD-668706)

The report contains basic research in the area of Cosmic Ray and Particle Physics. Author (TAB)

N68-27181 Missouri Univ., Rolla.

THEORY OF THE LUNAR PHOTOELECTRON ATMOSPHERE

Hal Emerson McCloud, Jr. (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-9123

By considering the mechanics of an electron projected into an arbitrary potential field together with Poisson's equation it is possible to set up a differential equation for the electrostatic potential. The equation may be integrated and the photoelectron density found as a function of height for four approximate models. A simple model based upon monoenergetic photons and monoenergetic electrons ejected vertically upward yields rough estimates of the parameters of interest. Another model takes into account the fact that the photoelectrons are ejected at all angles. A general model takes into account the illumination of the lunar surface by solar (black body) radiation and also the distribution in energy of the electrons ejected for each photon energy. An adiabatic gas model of the photoelectron atmosphere provides an independent check of the results. Assuming a metalic surface the electron density is of the order of 10^4 electrons/cm^3 at a half-height of the order of 1.5 cm above the lunar surface. The charge distribution produces an electrostatic force field capable of levitating particles of the order of 10^{-14} gm. Dissert. Abstr.

N68-27190# New York Univ., N. Y. Physics Dept.

COSMIC RAY NEUTRON STUDIES Final Report, 1 Apr. 1962–30 Jun. 1967

Serge A. Korff, Rosalind B. Mendell, and William G. Sandie 1 Dec. 1967 107 p refs
(Contract AF 19(628)-378)
(AFCRL-68-0006; AD-668551)

This report presents a study of the neutrons generated by the cosmic radiation. A series of balloon flights were made, in which the neutrons in the energy range between one and ten MeVs were measured, throughout the atmosphere. These flights were made from various stations, over a range of latitudes from near equatorial to near polar, and in time over several years. It was found that a large variation with solar activity exists, especially at the near-polar locations were the lowest-energy part of the incoming radiation is observable. The numbers of neutrons going into radiocarbon were calculated for various epochs as were the numbers escaping from the top of the atmosphere. The importance of studying the production of other isotopes including especially beryllium ten is stressed. Various solar acceleration mechanisms were also examined, with especial reference to those which on infrequent occasions inject spectacularly large amounts of radiation into the space surrounding the earth. Author (TAB)

N68-27208*# Oak Ridge National Lab., Tenn. Neutron Physics Div.

SOLAR NEUTRON TRANSPORT IN THE EARTH'S ATMOSPHERE

R. G. Alsmiller, Jr. and R. T. Boughner [1967] 29 p refs
(NASA Order R-104)
(NASA-CR-95145; ORNL-TM-2194) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The possibility of observing solar neutrons by neutron spectral measurements at aircraft altitudes is considered. When high-energy neutrons enter the atmosphere, they interact with the atmospheric nuclei to produce a nuclear cascade in much the same manner as do the incident cosmic-ray protons and alpha particles. The question considered here is the magnitude of the neutron flux per unit energy at various depths in the atmosphere due to incident solar-flare neutrons compared to that due to incident cosmic rays. Throughout the paper, consideration is restricted to latitudes where the earth's magnetic field shields the atmosphere from solar-flare protons, and thus neutrons induced in the atmosphere by such protons need not be considered. Author

N68-27234# Rand Corp., Santa Monica, Calif.

INITIAL VALUE METHODS FOR INTEGRAL EQUATIONS ARISING IN THEORIES OF THE SOLAR ATMOSPHERE

Harriet Kagiwada, Robert Kalaba, and Sueo Ueno Apr. 1968 25 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5576-PR; AD-668754)

A computationally useful initial-value theory for determining the intensity of radiation emerging normal to the surface of the atmosphere for comparison with observed profiles is discussed. In this theory the emergent intensity E is the solution of an initial-value problem in which the independent variable is the interval length, or x, the optical thickness. The solution is determined as the thickness is varied from x equals zero when E equals zero, to x equals the desired thickness value. The computational procedure is based on the ability of modern computers to effectively solve large systems of ordinary differential equations subject to a complete set of initial conditions. The differential-integral equations of the exact theory are replaced by a system of ordinary differential equations in which the definite integrals are approximated by sums according to a quadrature formula. A suitably chosen quadrature formula can yield a very good approximation. Author (TAB)

N68-27385*# Rice Univ., Houston, Tex. Dept. of Space Science.

ON THE VARIETY OF PARTICLE PHENOMENA DISCERNIBLE AT THE GEOSTATIONARY ORBIT VIA THE ATS-1 SATELLITE

J. W. Freeman, Jr. and J. J. Maguire [1967] 27 p refs
Presented at the Birkeland Symp. on Aurora and Magnetic Storms, Sandefjord, Norway, Sep. 1967 Submitted for publication
(Contract NAS5-9561)
(NASA-CR-95215) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The three most salient phenomena that have been observed with the Rice University ion detector aboard the ATS-1 synchronous orbit satellite were studied. These phenomena are, a gross pre-post/midnight asymmetry in the enhanced energetic charged particle fluxes observed on the night side of the earth, a magnetopause penetration to 6.5 R_E with the subsequent detection of discrete clouds of energetic particles executing repeated longitudinal drift about the earth, and bursts of very low energy, E < 50 eV, highly directional positive ions tentatively associated with hydromagnetic transients. Each of these phenomena are described in sufficient detail to illustrate the prominent facts. Author

N68-27386*# Rice Univ., Houston, Tex. Dept. of Space Science.

ANOMALOUS PARTICLE FLUXES AT THE SYNCHRONOUS ORBIT, 13–14 JANUARY 1967

J. W. Freeman, Jr. and J. J. Maguire Aug. 1967 21 p refs
(Contract NAS5-9561)
(NASA-CR-95216) CFSTI: HC $3.00/MF $0.65 CSCL 03B

On January 13 and 14, 1967 an intense magnetic storm occurred. Within three hours after the beginning of the main phase, a positive impulse was seen at low latitude stations. Coincident with this impulse anomalously high anisotropic particle fluxes were observed by the low energy ion detector aboard the synchronous satellite ATS-1. These particles are consistent with the interpretation that the magnetopause was pushed inward beyond 6.5 earth radii during this event. Subsequent to this anisotropic flux observed in the magnetosheath, there occurred three separate isotropic particle bursts in the pre-midnight hemisphere, separated in time by about two and one-half hours. High time resolution of the first two bursts gives evidence of a remarkable coherence, indicating that the detector may have observed a nearly monoenergetic cloud of plasma drifting essentially intact around the earth for at least two orbits. Author

N68-27390*# Stanford Univ., Calif. Inst. for Plasma Research.

ACCELERATION ON A GALACTIC SCALE

P. A. Sturrock [1967] 38 p refs Presented at the Tex. Symp. on Relativistic Astrophys., New York, 23–27 Jan. 1967
(Grant NsG-703; Contracts AF 49(638)-1321; N00014-67-A-0112-006)
(NASA-CR-84764; SU-IPR-157) CFSTI: HC $3.00/MF $0.65 CSCL 03B

An analogous process on a laboratory scale is provided by certain plasma experiments, in which a quiescent plasma exhibits a sudden explosive instability which in turn leads to acceleration of some particles to high energies. This comparison leads to the suggestion that a galactic explosion which leads to particle acceleration is typically a plasma instability. Various forms are suggested for the magnetic-field configuration to be associated with a newly condensed object with the mass of a galactic nucleus, tentatively identified as a quasar, and an evolved radio galaxy. The energy content of such configurations is estimated, and shown to be adequate to explain observed radio clouds. Discussion of a radio outburst of 3C 273 leads to the view that some of the radio emission from quasars is the result of collective plasma processes. Hence such outbursts provide direct evidence for the occurrence of plasma instabilities on a galactic scale. Author

N68-27464# California Univ., Berkeley.

ELECTRONS AND PROTONS IN LONG LIVED STREAMS OF ENERGETIC SOLAR PARTICLES

K. A. Anderson Jun. 1968 44 p refs

In 1966 and 1967 many long-lived streams of low-energy solar electrons and protons were observed near Earth. These streams were sometimes associated with bright flares which occurred many hours earlier and sometimes no individual flare could be found. In the latter case the particles are evidently to be associated in a general way with solar active centers as Fan *et al* (1968) have done. The long-lived solar events discussed here include energetic storm particles, delayed events and fluxes associated with solar active regions. It is suggested here that these are all probably the same basic phenomena viewed in somehwat different ways depending on the age of the region and its location on the solar disc. These events are usually associated with a depression in the sea-level neutron intensity and one of more sudden commencements of sudden impulses. Both electrons and protons are present in these events but in several cases electrons were not detected. The most unusual feature is that when both particle species are present, the electron flux is centered several hours before the proton flux. Author

N68-27582*# Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies.

LONG TERM TIME VARIATIONS OF THE PRIMARY COSMIC RAY ELECTRON COMPONENT

Jacques L'Heureux, Peter Meyer, Satya Dev Verma, and Rochus Vogt (Calif. Inst. of Tech.) Jun. 1967 10 p refs Presented at 10th Intern. Conf. on Cosmic Rays, Calgary, Can.
(Grants NsG-144-61; NsG-426; NSF-GP-4709; Contract AF 49(638)-1008)
(NASA-CR-95740; EFINS-67-49) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The intensity of primary cosmic ray electrons has been measured from 1960 through 1966 at balloon altitude over Ft. Churchill, Manitoba. Initial measurements were made with an energy-loss vs. range counter telescope from 1960 through 1964. From 1964 through 1966 an energy-loss vs. total energy counter telescope was used. Overlapping data exist for both instruments in 1964. Our results are consistent with the absence of a solar modulation effect for electrons in the 0.25 BV to 1.05 BV rigidity range. The experimental errors lead to an upper limit of 60% for the possible fractional change of the electron intensity over this period. Author

N68-28002*# Chicago Univ., Ill. Dept. of the Geophysical Sciences.

ANGULAR DEPENDENCE OF REFLECTED SOLAR RADIATION FROM SAHARA MEASURED BY TIROS 7 IN A TORQUING MANEUVER

Rene Mendez Jun. 1968 19 p refs
(Grant NsG-333)
(NASA-CR-95361; SMRP-RP-73) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Statistical analyses were made using observations of backscattered radiation recorded by Channel 3 (0.2 to 6.0 microns) of the TIROS 7 radiometer, as it passed over the Sahara Desert. Three orbits were selected for this study. In order that the results be consistent the areas involved were classified and labeled according to the terrain. A composite map of the area was then constructed from Gemini 11 pictures and Nimbus 1 AVCS pictures. Both closed mode scanning and alternating mode scanning have been used in order to obtain reflectance values from the ground at different angles of view. The following parameters have been considered: type of ground surface; scattering angle; satellite zenith angle; solar zenith angle; azimuth of the TSP at the scan point; azimuth of the sun at the scan point; and relative azimuth. The results show a nonisotropic reflection pattern with maxima of scattering at low and high scattering angles, and at close to 0° and 180° relative azimuth. A minimum is found at about 125° of scattering angle and at close to 90° relative azimuth. The anisotropy is generally greater at satellite zenith angles and solar zenith angles greater than 45° Author

N68-28248*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PROPAGATION OF THE SUDDEN COMMENCEMENT OF 8 JULY 1966 TO THE MAGNETOTAIL

M. Sugiura, T. L. Skillman, B. G. Ledley, and J. P. Heppner Jun. 1968 31 p refs
(NASA-TM-X-63247; X-612-68-235) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The solar flare of 7 July 1966 produced a sudden commencement on the earth at 2102 UT on 8 July. The OGO-3 satellite observed a sudden increase in the magnetic field in the magnetotail following the sudden commencement. Using the IMP-3 and Explorer 33 observations of the interplanetary shock that caused the sudden commencement, the propagation of the field increase from the front side of the magnetosphere to the tail is discussed. It is shown that the magnetospheric propagation of this perturbation toward the tail is faster than the propagation of the interplanetary shock just outside the bow shock. Based on the observations by OGO-3, the ground observations, and those made in interplanetary space by IMP-3 and Explorer 33, the interplanetary shock speed is estimated to be approximately 500 km/sec, with an Alfvén Mach number for the shock about 1.2. This is considerably lower than the 700 km/sec deduced from plasma measurements on Explorer 33. It is concluded that: (1) the observed magnetic field increase in the tail is unlikely to be due to an increased lateral pressure of the post-shock solar wind gas from the side of the tail; and (2) the transfer of additional polar magnetic flux to the tail due to the increase in the solar wind pressure on the front side of the magnetosphere can account for the tail field increase. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N68-26967*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
OWS AUXILIARY ATTITUDE CONTROL SYSTEM REQUIREMENTS
5 Sep. 1967 43 p
(Contract NAS8-21003)
(NASA-CR-61820; LMSC-A842322) CFSTI: HC $3.00/MF $0.65
CSCL 22A

A control system designed explicitly for the OWS on-orbit control requirements is considered with attention focused on estimation of the impulse requirements and analysis of the OWS motion during storage. Tabulated data are given on the sequence of flight events for Cluster A. The AAP S-4B that launches the LM/ATM is to be used as an auxillary control system to allow rendezvous and docking of CSM after the instrument unit has reached its life limit. Activities which determine the control impulse requirements are listed, and equations are derived for computing the moment of momentum about each control axis as the CSM and OWS dock. Equations are also formulated for determining the moment of momentum when the LM/ATM docks to the OWS, and estimating the control impulse during rendezvous. The torques acting on the OWS caused by the gravity gradient and aerodynamic forces are discussed. B.S.D.

N68-26993*# Philco Corp., Palo Alto, Calif. WDL Div.
INFLUENCE OF UNCERTAINTIES IN THE ASTRONOMICAL UNIT CONVERSION AND MARS PLANETARY MASS ON EARTH-MARS TRAJECTORIES
Paul J. Rohde 15 Sep. 1966 67 p refs
(Contract NAS8-20356)
(NASA-CR-61574; WDL-TR-3040) CFSTI: HC $3.00/MF $0.65
CSCL 03B

The influence of uncertainties in the planetary mass of Mars and the conversion of the astronomical unit to a laboratory unit on a variety of Earth-Mars trajectories is analyzed. The effect of the uncertainties in these two constants is shown in the form of deviations in the periaries radius at Mars and the resulting approach guidance velocity correction required for two guidance laws. The capability of an onboard navigation system to estimate the approach trajectory deviations is also analyzed. The navigation system consists of a 10 arc second sextant for star-planet measurements and a Kalman filter for the data smoothing. The results of the analysis indicate deviations in the periaries radius of 10 to 20 km for an uncertainty of 150 km^3/sec^2 in Mars planetary mass. The approach velocity corrections required are on the order of 5 to 10 meters/second. The uncertainty in the astronomical unit, conversion produces trajectory deviations that are quite trajectory dependent. Author

N68-27023# Hamburger Sternwarte (West Germany).
SPECTROPHOTOMETRY OF GALACTIC NEBULAE INTERNAL OPACITY AND INTERNAL MASS STRUCTURE OF H2 EMISSION REGIONS Final Scientific Report, 1 Nov. 1964–31 Oct. 1967
Karl A. Wurm 5 Nov. 1967 23 p refs
(Contract AF 61(052)-810)
(AFCRL-68-0078; AD-668541)

The unadequacy of the currently used spherical model (Stromgren Model) for the theoretical treatment of HII emission regions has been shown. This model neglects once the internal continuous opacity of HII atmosphere. The model disregards secondly the irregular cloudy structure of brighter HII regions. This irregular cloudy mass arrangement becomes evident as well from the irreguler monochromatic surface structure of emission nebulae as also in the case of the Orion nebula from the strongly varying radial velocities of the masses. The problem of the positions of the exciting stars of HII emission regions in the line of sight is also attacked. Exciting stars deeply involved within the bright and dense masses are certainly very rare. Investigated is also the often in HII fields observed positive correlation between the surface brightness in nebulae and the star density in the areas. This correlation appears very often, however, it does not represent a rule. This situation, the existence of such a correlation and its not rare violation is explained. Author (TAB)

N68-27029# Office of Research Analyses, Holloman AFB, N. Mex.
ROTATION OF THE ORBITAL PLANE OF A SATELLITE Final Report
Hermann O. F. Scharn Mar. 1968 45 p ref
(ORA-68-0003; AD-669067)

The rotation of the orbital plane of a satellite achieved by a thrust orthogonal to the radius vector and the velocity vector of the satellite is investigated as a function of the propellant mass-to-gross mass ratio, the thrust function and the motor burning time. The problem is treated with a new method which does not presume the knowledge of the powered flight trajectory of the satellite. The investigation is based on two properties of the unit vectors perpendicular to the planes of the osculating ellipses associated with the powered flight trajectory, namely the geodesic curvature and the length of the curve described by this unit vector while the satellite is on its transition course. With these two auxiliary terms the qualitative discussion of the angle between the orbital planes appears to become rather simple. For the quantitative determination of the angle between the orbital planes an ordinary homogeneous differential equation of the third order, which is valid for all types of orbits and thrust functions, is derived. In the special case of a constant acceleration of a satellite in circular orbit, its solution can be written immediately in closed form. Author (TAB)

N68-27068# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OBSERVATIONS OF THERMAL RADIATION OF THE MOON
N. P. Yesaulov and N. S. Nikulin 29 Sep. 1967 16 p refs
Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Krymsk. Astrofizicheskaya Observ. (USSR), no. 30, 1963 p 273–283
(FTD-MT-67-25; AD-668522)

Experimental measurements of the intrinsic thermal radiation of the moon were made by a telescope with a photoconductive cell of germanium alloyed with zinc and compensated by antimony and by a tower solar telescope with an optical-acoustic receiver. Isotherms of a small region of the moon at various phases are plotted. Transition from radiation fluxes obtained with measurements to temperature is carried out by reference (tying) to absolute measurements. Author (TAB)

N68-27075 California Univ., Berkeley.
THE INFLUENCE OF MASS LOSS ON THE EVOLUTION OF A RED GIANT STAR OF 5 SOLAR MASSES
Jack Eugene Forbes (Ph.D. Thesis) 1966 97 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8556

A method is described for computing the evolution of a stellar model subject to the ejection of matter from the surface. The method has been so devised that any existing stellar-evolution computing program for the more usual case of constant mass can easily be adapted for use in the case of variable stellar mass. Neither theoretical work done thus far nor the observational data permit the calculation of the rate of mass loss with any certainty, and an *ad hoc* assumption has therefore been made that the rate is proportional to the mass in the outer convective zone, or envelope. This is in qualitative agreement with observation in that the rate of loss is observed to the highest in red giants with the lowest surface temperatures, which also happen to be those for which the mass in the convective envelope is greatest. Dissert. Abstr.

N68-27146 Minnesota Univ., Minneapolis.
ZODIACAL LIGHT AND INTERPLANETARY DUST
Frederick Carl Gillett (Ph.D. Thesis) 1966 135 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-7725

Balloon observations of the brightness and polarization of the zodiacal light from above 100,000 ft. are reported. It is shown that there is a nearly unique model for the distribution of interplanetary dust which will account for these observations and the observations of the outer F-corona. The distribution of ecliptic inclinations of the zodiacal dust is very nearly that of the observed asteroids. It is shown that the asteroid belt could easily sustain the zodiacal cloud for the lifetime of the solar system and that collisions in the asteroid belt can supply enough small particles. This model predicts a loss mechanism in addition to the Poynting–Robertson effect and the necessary loss rate is in excellent agreement with the expected rate of sputtering by solar wind particles. The solar wind is shown to exert less drag on the zodiacal dust particles than solar radiation under "quiet" conditions, and although it may exceed the radiation drag during solar storms, the duration of such storms is too short to significantly affect the zodiacal dust. Dissert. Abstr.

N68-27161*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A STUDY OF ARTIFICIAL METEORS AS ABLATORS
Charles E. Shepard, John W. Vorreiter, Howard A. Stine, and Warren Winovich [1965] 49 p refs Presented at the Intern. Council of the Aeron. Sci., London, 11–16 Sep. 1966
(NASA-TM-X-59062) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Photographic meteor observations could provide more reliable information on the hazard to space travel if meteor ablation and radiation phenomena were better understood. This paper describes static tests conducted in an ultrahigh-enthalpy supersonic plasma jet with a number of materials having compositions thought to be typical of meteors in order to determine their effective heats of ablation and luminous efficiency factors. These values were then compared with calculated values and those commonly used in meteor analysis. Melting, foaming of the melt, and liquid run-off behavior were also examined to determine their effects on frontal area, apparent density, and mass loss rate. It was found that artificial meteors of gabbro or basalt ablate and radiate similarly to samples cut from natural stone meteorites, and that steel specimens duplicate the behavior of natural iron meteorite material: the comparable materials grow in frontal area, decrease in average density, and emit light in the same manner. K.W.

N68-27182# Brown Univ., Providence, R. I.
A STUDY OF TWO TOPICS IN GENERAL RELATIVITY: THE COSMOLOGICAL RED-SHIFT: GRAVITATIONAL WAVES
Garry Ludwig (Ph.D. Thesis) 1966 92 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-2263

This thesis investigates two different topics in general relativity. The first topic deals with the cosmological red-shift. The red-shift formula is rederived by two alternative methods that give new insight into how this frequency shift arises. The second topic deals with the generation of gravitational waves. Westervelt's result for the radiated gravitational flux due to the emission and absorption of electromagnetic waves is obtained in a more general form from a scalar expression for the gravitational flux. Defining a so-called ideal oscillator and using it as a model for a crystal, Weber's conclusion concerning the gravitational power radiated from a crystal driven off resonance is shown to contain two errors. First, this power depends primarily on the dielectric properties of the crystal, not as Weber claims, on its piezoelectric properties. Secondly, Weber appears to have neglected radiation from the generator driving the crystal off resonance. Dissert. Abstr.

N68-27186 California Univ., Berkeley.
THE TRIPLET SPECTRUM OF NEUTRAL HELIUM IN PLANETARY NEBULAE
Ralph Robert Robbins, Jr. (Ph.D. Thesis) 1966 170 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-8637

The object of this investigation is to calculate the emissions of the triplet states of neutral helium for various gaseous configurations approximating actual planetaries. In the first part, the equations of radiative capture and subsequent cascade are formulated for the triplet states, and a solution is found. Also, cross sections specifying the redistribution of electrons within the higher quantum levels by collisions are estimated. In the second part, the calculated line intensity ratios are modified to allow for the self-absorption effects arising from the metastability of the 2^3S level. The configurations treated are spheres of constant electron density and temperature and having a uniform distribution of helium atoms in the 2^3S level. Thus relative intensities are derived for a series of optical depths and expansion rates. In the calculations, the assumptions of complete redistribution and exact redistribution are tested as a function of both optical depth and rate of expansion. It is found that to produce a given change in the line intensity ratios requires a much greater optical depth than previous calculations had indicated. This effect is particularly dramatic when the expansion of the nebula is incorporated. Dissert. Abstr.

N68-27198# Hebrew Univ., Jerusalem (Israel). Dept. of Meteorology.
NUMERICAL STUDIES OF PLANETARY CIRCULATIONS IN A MODEL ATMOSPHERE Final Scientific Report, 1 Aug. 1965–31 Jul. 1967
Abraham Huss Dec. 1967 192 p refs
(Grant AF-EOAR-65-89
(AFCRL-68-0114; AD-668540)

The evolution of general circulation patterns has been studied on a beta-plane, by means of two-level quasi-geostrophic models, including diabatic heat sources and friction. In the first experiment the influx of heat per unit column was made proportional to the temperature difference at the ocean-air interface, and to the geostrophic wind speed at this level. The factor of proportionality was

independent of the sign of the temperature difference. In the second experiment its value was reduced by a factor of 10 whenever the air temperature exceeded the ocean temperature. In the third experiment a humidity distribution, evaporation, precipitation and release of latent heat were introduced. The best results were obtained in the third experiment, in which a well-defined 'index cycle' with a period of about 13 days occurred. Integrations were performed by means of a model without diabatic heat sources or surface friction, with initial easterly and initial westerly flow.
Author (TAB)

N68-27197*# General Precision, Inc., Little Falls, N. J. Kearfott Group.

RESEARCH IN THE RESTRICTED PROBLEMS OF THREE AND FOUR BODIES Final Scientific Report

Paul B. Richards, Irwin S. Bernstein, Winchung A. Chai, Jane Cronin, Jordan Ellis et al Mar 1968 12 p *refs*
(Contract AF 49(638)-1466)
(NASA-CR-95107; AFOSR-68-0912; AD-669136) CSCL 03C

Seven studies have been conducted on research in the existence and nature of solutions of the restricted problems of three and four bodies. The details and results of five of these research investigations have already been published, and the latest two studies will be published shortly. A complete bibliography of publications is included in this report. This research has been primarily qualitative and has yielded new information on the behavior of trajectories near the libration points in the Earth-Moon-Sun and Sun-Jupiter-Saturn systems, and on the existence of periodic trajectories about the libration points of the circular and elliptical restricted four-body models. We have also implemented Birkhoffs normalization process for conservative and nonconservative Hamiltonian systems with equilibrium points. This makes available a technique for analyzing stability properties of certain nonlinear dynamical systems, and we have applied this technique to the circular and elliptical restricted three-body models. A related study was also conducted to determine the feasibility of using cislunar periodic trajectories for various space missions. Preliminary results suggest that this concept is attractive for space flight safety operations in cislunar space. Author (TAB)

N68-27256# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

OPTIMAL COPLANAR FLIGHT BETWEEN ORBITS WITH CALCULATION OF INTERNAL RESERVE OF MASS, PROPORTIONAL TO TIME OF FLIGHT [KOMPLANARYY OPTIMAL'NYY POLET MEZHDU ORBITAMI S UCHETOM VNUTRENNEGO ZAPASA MASSY, PROPORTISIONAL'NOGO VREMENI POLETA]

S. N. Kirpichnikov *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 139–153 refs (See N68-27244 16-19)

The coplanar flight between given orbits is considered. The inner supply mass proportional to the time of flight is taken into account. The quantity of initial mass is minimized, the final mass (without the inner supply mass) being fixed. The only impulse on the initial orbit creates this flight. The initial, intermediate, and final trajectories are Kepler orbits. The concrete motion on the orbits is both taken into account and is not taken. The flight between orbits of small eccentricities, the flight between circular orbits and other special cases are investigated. Author

N68-27257# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF SPECTRAL SCHEME OIII, UTILIZED IN CALCULATION OF RECOMBINATION SPECTRA OF STARS AND NEBULAE [ISSLEDOVANIYE SPEKTRAL'NOY SKHEMY OSH, ISPOL'ZUYEMOY PRI RASCHETE REKOMBINATSIONNOGO SPEKTRA ZVEZD I TUMANNOSTEY]

A. A. Nikitin *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 154–171 refs (See N68-27244 16-19)

Deviations from LS scheme in the energetic scheme OIII are considered. The probabilities of the transitions connected with these deviations are calculated and their astrophysical meaning is discussed. Author

N68-27258# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A STATISTICAL METHOD TO MAKE APPARENT THE MULTIPLE SYSTEMS OF STARS [STATISTICHESKIY SPOSOB VYYAVLENIYA KRATNYKH SISTEM ZVEZD]

B. I. Fesenko *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 172–178 refs (See N68-27244 16-19)

The paper considers a statistical method for determining the average multiplicity of systems in a stellar field having a certain brightness. The method, based on the scattering of stellar frequencies, is a modification of a previous method for the detection of binary stars. The method considers only systems in which the components are individually visible on the photograph and excludes a large number of binary systems in which one of the components is brighter and one is weaker than the limiting value. In the present paper, the method is applied to the star count data found on three charts of the Mt. Palomar atlas and in the Parisian zone of the Carte-du-Ciel 24°. The average multiplicity was found to be 1.59 ± 0.14 and 1.018 ± 0.021, respectively. Author

N68-27286*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LABORATORY SIMULATION OF LUNAR SURFACE EROSION BY ROCKETS

Norman S. Land and D. William Conner [1967] 12 p *refs*
Presented at the 13th Ann. Inst. of Environ. Sci. Tech. Meeting, Washington, D. C., 10–12 Apr. 1967
(NASA-TM-X-59863) CFSTI: HC$3.00/MF$0.65 CSCL 22A

An experimental technique which utilizes models for laboratory simulation of lunar surface erosion by rockets is described. Included in the discussion are: (1) a brief description of the physical characteristics of the jet impinging a surface; (2) the scaling factors considered in devising the experiments; and (3) a description of the experimental apparatus employed. Results of the experiments, covering a range of parameters, indicated that for a given jet the digging rate is affected by jet distance from the surface, by the type of material, and by material size. A.L.

N68-27296# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RADIO ASTRONOMY [RADIOASTRONOMIYA]

Yu. N. Pariyskiy and S. E. Khaykin *In its* Radio 70 Yr. 30 Jun. 1967 p 166–184 (See N68-27287 16-07)

This article describes developments and problems connected with the growth of the radiotelescope and enumerates the significant achievements thus far attained. The radiotelescope has opened a field for study of radiospectroscopy devoted to the investigation of the chemical composition of the universe. Various recommendations for future antenna designs are presented. Author

N68-27297# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RADAR INVESTIGATIONS OF THE SOLAR SYSTEM PLANETS [RADIOLOKATSIONNYYE ISSLEDOVANIYA PLANET SOLNECHNOY SISTEMY]

B. I. Kuznetsov and I. V. Lishin *In its* Radio 70 Yr. 30 Jun. 1967 p 185–201 (See N68-27287 16-07)

This article is a dissertation on the progress of cosmic radar and successes in refining man's knowledge of planets previously known only by optical means. Cosmic radar techniques are cited as aids to actual exploration of space by spaceships and automatic space stations. As an example, the authors refer to the fact that radar helped in measuring more accurately the astronomical unit and the data so obtained were used in launching interplanetary station Mars-1 in 1962. Author

N68-27320 California Univ., Berkeley.

THE LOCAL NEUTRAL HYDROGEN GAS AND ITS RELATIONSHIP TO GOULD'S BELT

Henry Kimball Hansen (Ph.D. Thesis) 1966 99 p

Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8571

A series of 21-cm observations were made in order to study the general distribution of neutral hydrogen in the galaxy and the possible correlation of this distribution with Gould's Belt of Bright Stars. The observations consist of drift curves taken across the galactic plane and out to 30° galactic latitude while using a receiver bandwidth of 1 MHz. The hydrogen distribution that is observed shows a strong concentration toward the galactic plane, but there is also considerable hydrogen present at high latitudes. The general features of the hydrogen distribution show a correlation with the distributions of dark material and bright diffuse nebulae that are observed in the galaxy. But the correlation with Gould's Belt is not unambiguous. The galactic ridgeline observed in the integrated hydrogen distribution falls very close to the mean galactic plane in the central regions of the galaxy; but in other parts of the galactic circle the ridgeline departs from the plane by as much as four degrees, and in one area it shows two distinct branches. To study the radial distribution of neutral hydrogen in the galaxy, a model consisting of concentric rings of varying densities was constructed which reproduces the observed integrated densities along the ridgeline. Dissert. Abstr.

N68-27321 Michigan Univ., Ann Arbor.

STRUCTURE AND EVOLUTION OF LOW MASS STARS

Harold Conrad Graboske, Jr. (Ph.D. Thesis) 1966 251 p

Available from Univ. Microfilms: HC $11.50/MF $3.25 Order No. 67-8258

The structure and evolution of low mass stars are investigated to determine the dominant physical factors which govern their evolution. The major physical problem is the accurate evaluation of the thermodynamic properties of moderately dense stellar gases, where electrostatic interaction between the charged particles composing the gas modify its thermodynamic behavior. The problem of evaluating the thermodynamic properties of an electrostatically interacting, partially degenerate gas can be divided into three parts: the partially ionized gas, the low density plasma, and the high density plasma. A composite equilibrium composition (ionization and dissociation) and equation of state for a non-ideal hydrogen gas is constructed. A star model computation program is developed, based on the Henyey method, and used to construct an evolutionary sequence of models for 0.1 and 0.05 $M_\odot$ stars. The results of the stellar model calculations are that pressure ionization effects must be included in the constitutive physics to compute realistic models. The dominant physical factor governing the pre-main sequence of evolution of these stars is the surface boundary condition. The inclusion of improved low temperature opacities causes major modifications in the model structure. Dissert. Abstr.

N68-27383*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.

THE PRE-HAYASHI PHASE OF STELLAR EVOLUTION

A. G. W. Cameron [1968] 16 p refs Presented at Symp. on Low Luminosity Stars, Charlottesville, Va. Supported in part by NSF

(NASA-TM-X-61135) CFSTI: HC$3.00/MF$0.65 CSCL 03B

The structure and evolution of protostellar disks ("stellisks") are being studied. These are flattened fragments of a collapsed interstellar cloud. Their angular momentum properties are those appropriate to uniformly rotating spheres of variable density distribution. Corresponding to each angular momentum distribution there are two separate density distributions in which there is centrifugal equilibrium in the disk. One distribution is very flat, rotates approximately uniformly, and probably deforms into a close binary pair. The other is axially condensed and is the probable precursor of single stars and planetary systems. In stellisks of the latter kind with lower densities near the rim, one or a few separate rings form near the outer edge. Since stellisks are formed as a result of a dynamical collapse process, they have an initial stage of short-lived turbulence. This transports angular momentum outwards and increases the tendency for formation of outer rings. Author

N68-27404*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

AN ASSESSMENT OF LIFTING REENTRY FLIGHT CONTROL REQUIREMENTS DURING ABORT, TERMINAL GLIDE, AND APPROACH AND LANDING SITUATIONS

Milton O. Thompson, Joseph Weil, and Euclid C. Holleman Washington [1967] 17 p refs Presented at AGARD Specialist's Meeting on Stability and Control, Cambridge, Eng., 20–23 Sep. 1966

(NASA-TM-X-59119) CFSTI: HC$3.00/MF$0.65 CSCL 22C

The results of the X-15 research airplane and M-2 lifting-body flight programs and various simulation programs are summarized for pertinence to the control requirements for manned lifting reentry. Piloted reentries have been successfully accomplished with several degrees of control-system sophistication and at a variety of reentry conditions, some more severe than expected during orbital reentry. Control requirements for terminal glide are indicated to be less severe than those for high-performance aerodynamic vehicles. Approach and landing of unpowered low-lift-drag -ratio (L/D) vehicles is well within the pilot's capability. Initiation of the landing flare at airspeeds greater than the speed for maximum lift-drag ratio proved to be an effective landing technique for accurate landing of low L/D vehicles. Author

N68-27417*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

TRAJECTORY OPTIMIZATION USING FAST-TIME REPETITIVE COMPUTATION

James S. Raby and Rodney C. Wingrove [1966] 33 p refs Presented at the Fall Joint Computer Conf., San Francisco, 8–10 Nov. 1966

(NASA-TM-X-59216) CFSTI: HC$3.00/MF$0.65 CSCL 22C

A perturbation method of computing optimum trajectories is described. This method uses fast-time repetitive computations in determining control impulse response functions and requires only dynamic solutions of the state equations. The solution of additional linear adjoint equations is not required. Both a hybrid and a digital computer mechanization of this impulse response method are described. Sample solutions for each computer mechanization are presented, using the same problem formulation in each case. The problem constraints were that a reentry vehicle travel a specified range, that the control remain within specified limits, and that the heat input to the vehicle be minimized. A comparison is made between the hybrid computer and the digital computer mechanizations, each computed near optimum trajectories in about 2 minutes and full optimum trajectories in about 5 minutes of computer time. Author

N68-27466*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

DIRECTIONAL DISCONTINUITIES IN THE INTERPLANETARY MAGNETIC FIELD

Leonard F. Burlaga Jun. 1968 38 p refs

(NASA-TM-X-63243; X-616-68-224) CFSTI: HC $3.00/MF $0.65 CSCL 03B

It is shown that the interplanetary magnetic field has different characteristics on different scales, and it is noted that a given physical theory may not be applicable or relevant on all scales. Four scales are defined in terms of time intervals on which the data may be viewed. Many discontinuities in the magnetic field direction are seen on the mesoscale ($\approx$4 days, $\approx$1 AU). The characteristics of such directional discontinuities which were observed by Pioneer 6 during the period December 16, 1965–January 4, 1966 are presented, with special emphasis on their distribution in time. Previously, it was suggested that such discontinuities are simply boundaries of spaghetti-like filaments extending from the sun to the earth. Here it is shown that on the mesoscale unique filaments with sharp boundaries containing well-ordered magnetic fields are not always seen although discontinuities are always present at $\approx$1 AU. Thus, the interplanetary medium appears to be discontinuous rather than filamentary. The filamentary model implies that discontinuities originate at the sun and are convected with the solar wind. The discontinuous model allows the additional possibility that the discontinuities form in the interplanetary medium far from the sun. Author

N68-27467*# California Inst. of Tech., Pasadena.

THE DYNAMICS OF VARIABLE STARS

R. F. Christy [1967] 20 p refs Presented at the Natl. Meeting of the Soc. for Ind. and Appl. Math., Washington, D. C., 13 Jun. 1967
(Grant NSG-426; Contract Nonr-220(47))
(NASA-CR-87250) CFSTI: HC$3.00/MF$0.65 CSCL 03B

Several closely related classes of variable stars, here called Cepheid variables, have long been known, as a result of detailed observation, to be vibrating in a spherically symmetric dilational mode. The purpose of the work described here has been to understand this motion and thereby to be able to apply the extensive data on variable stars in augmenting our knowledge of the stars. The coupled equations of spherical hydrodynamics and radiation diffusion have been solved numerically as an initial value problem for a variety of stellar models. Unstable models show a growing amplitude of pulsation which ultimately levels off at a stable maximum amplitude of periodic motion. This final motion and the associated large amplitude light variation agree closely with observed variables. Check calculations show that the results are reliable. The interior dynamics have been examined in order to find the physical cause of the instability and also in order to understand peculiar secondary features of the pulsation. In addition, overtone pulsation in the first radial overtone has been studied. In a few cases, the instability can lead to stable large amplitude periodic motion in either the fundamental or the first overtone, depending on the initial conditions. Author

N68-27475*# National Aeronautics and Space Administration, Washington, D. C.

THE ZODIACAL LIGHT AND THE INTERPLANETARY MEDIUM

J. L. Weinberg ed. (Hawaii Univ.) 1967 395 p refs Papers presented at the Symp. held in Honolulu, Hawaii, 30 Jan.–2 Feb. 1967
(NASA-SP-150) GPO: HC$3.00; CFSTI: MF$0.65 CSCL 03B

Conference papers on zodiacal light in the interplanetary medium deal with photometric and meteor observations, particle collection and impact, scattering properties, dynamics and the earth's dust cloud, solar wind, and the origin and evolution of zodiacal dust. For individual titles see N67-27475 to N67-27525.

N68-27476*# Hawaii Univ., Honolulu. Haleakala Observatory.

A PROGRAM OF GROUND-BASED STUDIES OF THE ZODIACAL LIGHT

J. L. Weinberg and H. M. Mann *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 3–8 refs (See N68-27475 16-30)
(Grants NsG-676; NSF GA-326)

Recent results from ground-based studies conducted at the Haleakala Observatory in Hawaii are summarized, along with some current studies in several critical areas related to zodiacal light. Multiplier phototube calibration data collected in 1965 and 1966 as well as characteristics of the interference filters used are tabulated. Nonzodiacal light sources of polarization in nightglow, separation of zodiacal light from starlight and airglow, the comet 1965 and the zodiacal light, and lunar libration clouds are discussed. M.W.R.

N68-27477*# California Univ., La Jolla.

MEASUREMENT OF THE BRIGHTNESS AND POLARIZATION OF ZODIACAL LIGHT FROM BALLOONS AND SATELLITES

F. C. Gillett *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 9–15 refs (See N68-27475 16-30)

Observations of the night sky were made from above the airglow layer by the OSO 2 satellite, and spatial separation of the airglow from the zodiacal light and interstellar light was accomplished by confining the airglow emission to a narrow band around the earth. Zodiacal light monitoring observed the brightness and polarization of the night sky above the airglow layer in the three spectral regions at elongations between 66 and 94° and unspecified ecliptic inclination. Time variations with sky brightness are discussed for a single orbit, over several orbits, and over long periods of time. Balloon observations of the night sky are also reported, and data on the photometers, cameras, and model calculations are included. M.W.R.

N68-27478*# Oxford Univ. (England).

TOWARD A UNIFICATION OF ECLIPSE AND ZODIACAL-LIGHT DATA

D. E. Blackwell and M. F. Ingham *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 17–21 refs (See N68-27475 16-30)

Observations that are needed to give the dust density in the region $4R_{\odot} < R < 108R_{\odot}$ are considered, and the importance of unifying data concerning the solar corona and the zodiacal light is emphasized in terms of presenting a more realistic assessment of observations. Intensity and polarization of the F-component of the solar corona are discussed, and mention is made of some data on the zodiacal light. A brief survey is included of data on the interpretation F and p_F which, in addition to infrared excess, are presently the only source of knowledge on dust within 100 $R_{\odot}$ within the sun. Difficulties of interpretation are related to, among other things, the calculation of infrared excess. These data indicate the importance of including the variation of the properties of the dust cloud with distance from the sun. M.W.R.

N68-27479*# Missouri Univ., Columbia.

MULTICOLOR PHOTOMETRY OF THE ZODIACAL LIGHT

Alan W. Peterson *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 23–31 refs (See N68-27475 16-30)

Photometric observations of the zodiacal light yielding estimates of the spectral-energy distribution are reviewed from the literature. Color-index measurements based upon two-color photometry are, in general, uncertain by ±0.1 to ±0.2 magnitude and suggest that the zodiacal light is about the same color as sunlight. The role of the zodiacal-light color in determining models of the interplanetary-dust distribution is discussed. It is suggested that a zodiacal light having very nearly the same spectral energy distribution as the sun is possible even with many submicron particles in the dust cloud. Absolute calibration and extinction measurements were obtained from nightly star readings. In the wavelength range from 3600Å to 7650Å the measured spectral energy distribution of the zodiacal light was fitted to a law of the form $A\lambda^n$. A mean value of the exponent $n = 0.065 \pm 0.049$ (pe) was obtained. The value $n = 0$ corresponds to a spectral type GI(V) star. In the range of elongation from 50° to 60°, n attains a maximum value of 0.085 and decreases toward larger and smaller elongations. The corresponding color index for a star with the above spectal-energy distribution is $B-V = 0.61 \pm 0.02$ (pe) or very nearly identical to sunlight. Measured zodiacal-light brightness and the measured extinction coefficient show no appreciable correlation. Author

N68-27480*# Odessa Polytechnic Inst. (USSR).

REDUCTION OF PHOTOMETRIC MEASUREMENTS OF ZODIACAL LIGHT FOR THE INFLUENCE OF TWILIGHT RADIATION

N. B. Divari *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 33–36 refs Submitted for publication (See N68-27475 16-30)

Twilight radiation from the sky was taken into account in reducing photometric measurements of zodiacal light. The twilight component of the radiation, i.e., the brightness of the sky, is represented as the sum of the brightnesses of the primary and secondary twilights. The primary twilight is governed by the scattering of solar radiation by dust and gases of the earth's atmosphere, while the secondary twlight is governed by the scattering of the primary twilight component by the troposphere. It is noted the brightness of the twilight sky can vary by a factor of 10 in the course of a few days because of the concentration of dust in the earth's atmosphere and variations in the coefficient of transparency. M.W.R.

N68-27481*# Tokyo Astronomical Observatory (Japan).

ROCKET OBSERVATIONS OF THE BRIGHTNESS OF THE ZODIACAL LIGHT

Hiroyoshi Tanabe and Masaaki Huruhata *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 37–40 refs (See N68-27475 16-30)

The brightness of the zodiacal light was measured at 4300Å, 5300Å, and 6000Å, from a rocket launched in Japan that reached a maximum altitude of 328 km. Measurements were made between 41° to 15° from the sun along the ecliptic to provide coverage of the observational gap between the inner zodiacal light and the outer corona observed from the ground and from aircraft, respectively, at the time of solar eclipse. Results agree fairly well with ground observations, but show a slightly steeper gradient of brightness with elongation than those of ground observations; and indicate a slightly higher value for the brightness of the outer corona at 6000Å than that obtained by Blackwell. Author

N68-27482*# Tokyo Astronomical Observatory (Japan).

OBSERVATIONS OF THE PHOTOMETRIC AXIS OF THE ZODIACAL LIGHT

Keiji Saito and Masaaki Huruhata *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 41–43 refs (See N68-27475 16-30)

Photoelectric observations of the photometric axis of the zodiacal light were made at Manuae Island in the South Pacific around the date of the total solar eclipse on May 30, 1965, when the ecliptic was perpendicular to the horizon. Comparisons were made with previous instrumental observations and with visual observations. The concentration of zodiacal light particles near and inside the Earth's orbit does not seem to be on the invariable plane, but rather inclined to the orbital plane of Venus and Mars as was pointed out by Hoffmeister. Another possibility referred to is that the concentration tends to the equatorial plane of the Sun. No effect by the particles in the Earth–Moon system can be found. Author

N68-27483*# New Mexico Univ., Albuquerque.

OBSERVATIONS OF THE ZODIACAL LIGHT BY MEANS OF TELEMETRY FROM BALLOONS

Victor H. Regener and Edwin L. Vande Noord *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 45–47 refs (See N68-27475 16-30)
(Grants NSF GP-2714; NSF GA-330)

A lightweight balloon-borne telescope equipped with telemetry for zodiacal-light intensity and polarization readings in three colors was flown from Albuquerque, New Mexico, during the International Quiet Sun Years. Two flights were completely evaluated. Absolute extraterrestrial intensity and color readings were obtained by using fixed stars as calibration sources. The results show that the exponent of the power law $I = C\epsilon^k$ is $K = -3.03 \pm 0.14$ in the blue ($\lambda_{eff} = 4350$Å) and $K = -3.01 \pm 0.09$ in the visible ($\lambda_{eff} = 5500$ Å) regions of the spectrum, where I is the intensity of the zodiacal light on the ecliptic between elongation angles from the Sun of $25° < \epsilon < 35°$. The color index of the zodiacal light in that region was found to be $B-V = 0.60 \pm 0.04$ ($B-V = 0.62$ for the Sun). The average degree of polarization of the zodiacal light over the same region was found to be 0.16 ± 0.02 in the visual and 0.17 ± 0.02 in the blue. Author

N68-27484*# Kitt Peak National Observatory, Tucson, Ariz.

ZODIACAL-LIGHT OBSERVATIONS FROM A SOUNDING ROCKET

R. D. Wolstencroft (Roy. Obs., Edinburgh) and L. J. Rose *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 49–56 refs *Its* Contrib. No. 238 from Kitt Peak Natl. Obs. (See N68-27475 16-30)

Surface brightness, color index, and state of polarization of the zodiacal light were measured from an Aerobee 150 sounding rocket during the 245-sec period when the rocket was above an altitude of 130 km. Observations were corrected for background sky radiation. Surface brightness of zodiacal light close to the ecliptic were tabulated; and extrapolated brightness at the south pole was found to exceed that at the north pole by 15% and the gegenschein brightness profile was found to lie 3° south of the ecliptic. Dependence of color ratio on elongation and degree of polarization of zodiacal light at 7000 Å as a function of elongation are illustrated. Comparisons with previously collected data are included. M.W.R.

N68-27485*# Columbia Univ., New York.

A FIVE-COLOR PHOTOMETRY AND POLARIMETRY OF THE ZODIACAL LIGHT: A PRELIMINARY REPORT

R. D. Wolstencroft and J. C. Brandt (NASA. Goddard Inst. for Space Studies) *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 57–62 refs Prepared jointly with Kitt Peak Natl. Obs. *Its* Contrib. No. 301 from Kitt Peak Natl. Obs. (See N68-27475 16-30)
(Grant NGR-33-008-053)

Simultaneous observations in five colors of the brightness and state of polarization of the night-sky radiation were secured from Mount Chacaltaya, Bolivia, during July and August 1964. The spectral range was from 3650Å to 9515Å. Preliminary analysis of part of these data are presented; and a description of the wavelength dependence of the zodiacal light brightness and polarization, possible complicating emissions from the atmosphere, and some remarks concerning circular polarization of the radiation scattered by dust are included. Author

N68-27486*# Bordeaux Univ. (France). Observatory.

PHOTOMETRY OF ZODIACAL LIGHT AND ATMOSPHERE CONTINUUM BY H-M METHOD AND BARBIER CORRELATIONS, AND TENERIFE RESULTS ABOUT THE SHAPE OF THE ZODIACAL CLOUD

Rene Dumont *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 63–69 refs (See N68-27475 16-30)

Zodiacal light, gegenschein, and airglow continuum observations were made at Tenerife Island; and airglow, interplanetary, and stellar components of the night sky were separated by an H-M (Hauteurs Multiples) method that involves choosing any fixed direction among the stars and recording final brightness in the course of dirunal motion by using the largest possible variation of zenith distance. Difference in behavior of the isophates of the gegenschein from that of the far zodiacal band is discussed; and the axis of zodiacal cloud is given from observations 90° away from the sun when the earth crosses the solar equatorial plane. M.W.R.

N68-27487*# Universidad de la Laguna (Spain). Observatorio del Teide.

RECENT POLARIZATION MEASUREMENTS OVER THE SKY AT TENERIFE ISLAND

Francisco Sanchez Martinez *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 71–73 refs (See N68-27475 16-30)

Amount of polarization of the night sky in the 5000 Å region over Tenerife Island was measured with a 12-in Cassegrain photoelectric telescope, and stars of visual magnitude less than 12.5 were excluded from the field. The main parameter and perhaps the only, upon which the true polarization of zodiacal light depends is the angular distance from the sun; and this parameter appears to be maximum, 0.18, at 60° and reaches zero beyond 160°. Mean curves for the true zodiacal polarization versus solar elongation were uniformly lower than those obtained by Weinberg by only 0.04 and varied greatly from those obtained by Elsasser and Blackwell-Ingham. All curves were considered valuable near the ecliptic. Airglow and starlight background corrections are discussed. M.W.R.

N68-27488*# Manchester Univ. (England).

PROBLEMS OF SPECTROPHOTOMETRY OF THE ZODIACAL LIGHT

J. F. James *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 75–78 refs (See N68-27475 16-30)

Spectrophotometric methods for observing the zodiacal light and similar faint extended sources were surveyed, beginning with measurements made as early as 1933 and 1940 when no Fraunhofer lines were apparent and the airglow line at 5577 Å was the only identifiable feature. The first deliberate search for these lines at long elongation were made in 1961 by Blackwell and Ingham using a plane-grating spectrograph at about 2 Å resolution with high aperture Schmidt optics. More sophisticated techniques were used for detailed study of one of these lines. Illustrations are included for the zodiacal light interference spectrometer, an iridometer (focal isolation spectrometer), and the Michelson multiplex interference spectrometer. Typical LR (light grasp and resolving power) products for various instruments are tabulated. M.W.R.

N68-27489*# Naval Research Lab., Washington, D. C.

NONECLIPSE OBSERVATIONS OF THE F-CORONA

M. J. Koomen and R. Tousey *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 79–86 refs Sponsored by NASA (See N68-27475 16-30)

The solar corona from $R = 3$ to $R_s = 11$ was recorded photographically with rocket-borne coronagraphs on June 28, 1963, and April 28, 1966. Coronal brightnesses were two or more times greater than the model derived from measurements during total solar eclipses. The tentative conclusion was that measurements of the F-corona during a solar eclipse do not record all the zodiacal light and that some of the zodiacal cloud may lie between Earth and Moon where it is shadowed. The rocket-coronagraph experiment was repeated on November 12, 1966. The time selected placed the Moon in the field of view, so as to eclipse the K-corona and the part of the F-corona beyond itself, and also to cast a shadow into the F-corona between itself and the Earth. This time the coronal brightness was lower than previously and in approximate agreement with the model corona. Inspection of the Moon's image suggested that little zodiacal material lay between the Moon and Earth. Since all coronagraphs had identical optical systems and were prepared, cleaned, and calibrated in the same way, it is tentatively concluded that the variable F-coronal brightness is real and may result from variable quantities of scattering material between Earth and Moon. Author

N68-27490*# Sternwarte der Deutschen Akademie der Wissenschaften, Sonneberg (East Germany).

SOME REMARKS CONCERNING THE ZODIACAL LIGHT

C. Hoffmeister *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 87–88 refs (See N68-27475 16-30)

General comments with regard to the topological problems of the zodiacal light are offered by Hoffmeister who reviews some of his findings that go back to 1932 and 1940. Mention is made of some phenomena in the airglow and the relationship of inner planet orbits and the zodiacal light. M.W.R.

N68-27491*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

VISUAL OBSERVATIONS OF LUNAR-LIBRATION-CENTER CLOUDS

William H. Allen, Walter J. Krumm, and Robert J. Randle *In its* The Zodiacal Light and the Planetary Medium 1967 p 91–95 refs (See N68-27475 16-30)

Luminosities were observed at previously noted faintly luminous clouds at the triangular libration center of the earth–moon system. These observations were at two clouds several degrees apart at the trailing libration center (L_5) and a single larger cloud at the leading libration center (L_4). The observed luminosities maintained the same position relative to the predicted position on successive nights. While the physical mechanism producing the observed luminosities is not sharply bounded, a local particle concentration by a factor of 100 is considered necessary to produce the observed luminances by isotropic scattering. Results are tabulated for absolute brightness threshold and acuity tests given to four observers using a newly developed visual parameter tester for the former and both a Landoldt "C" ring chart and a Bausch and Lomb orthorator that gives Snellen equivalent values for the acuity testing. M.W.R.

N68-27492*# Lockheed Missiles and Space Co., Sunnyvale, Calif.

LUNAR-LIBRATION-CLOUD PHOTOGRAPHY

J. Wesley Simpson *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 97–107 refs (See N68-27475 16-30)

Visual, photographic, and densitometric analyses have established the presence of lunar libration clouds, including the observation of the L_5 libration cloud on three of four successive nights in January 1964. It is noted that the clouds moved among the stars at a daily rate closely approximating that of the moon. Studies relating to lunar libration clouds made during the past five years are reviewed, along with a search for clouds located at the Lagrangian points in the earth-moon system using various types of ephemerides. Density-gradient contour plots of libration clouds are illustrated, along with an overlay of visual plot and densitometer trace. Relationship of contours, pattern center, and size to visual plots against the star field is discussed. M.W.R.

N68-27493*# Naval Research Lab., Washington, D. C.

PARTICLES OF UNKNOWN ORIGIN PHOTOGRAPHED AT ROCKET ALTITUDES

R. Tousey and M. J. Koomen *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 109–113 refs Sponsored by NASA (See N68-27475 16-30)

Photographs of the solar corona from R = 3.5 to 11, made from Aerobee 150 rockets with externally occulted Lyot coronagraphs, show tracks of particles in the altitude range from 120 to 204 km. On the flight of June 28, 1963, more than 35 particles were recorded, at distances ranging at least to 500 meters. Their diameters lay in the range from 10μ to 30μ. On April 28, 1966, two coronagraphs flown side by side made identical and simultaneous exposures of many more particles than were previously recorded. The separation between the objective lenses of the two coronagraphs makes it possible to triangulate and obtain ranges and particle trajectories with much greater precision than on the first flight. The experiment was repeated on November 12, 1966, and this time many fewer particles were recorded. Analysis of the photographs for all fights indicate that many particles were far away. Since the Sun's altitude was about 30° at the time of flight, the many particles recorded on the ascent lay in a cone ahead of and above the rocket. Because of the characteristics of their tracks, it is proposed that many of the particles are of natural origin, rather than ejected from the rocket. A large population of such particles would contribute significantly to the brightness of the corona, as photographed from the rocket. Author

N68-27494*# Massachusetts Inst. of Tech., Cambridge.

POSSIBILITY OF CONTINUOUS MEASUREMENT BY OPTICAL RADAR OF THE INFLUX ON EARTH OF EXTRATERRESTRIAL DUST

Giorgio Fiocco *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 115–117 refs (See N68-27475 16-30)
(Grants NGR-22-009-114; NGR-22-009-131)

Nightly average measurements of the influx of micrometeorites in the earth's atmosphere and the gross features of their velocity distribution and of their ballistic characteristics were made by optical radar; and design features are discussed for a system capable of continuously monitoring the influx of extraterrestrial dust are described. In interpreting optical radar data, contributions due to molecules must be seperated from those due to dust. Since it was found difficult to provide absolute calibrations of useful accuracy, the relative intensity of echoes as a function of range were measured assuming that in some range of heights the contributions due to molecules prevail and that the molecular distribution with height follows a standard behavior. The presence of an excess of scatterers at specific heights can thus be inferred. M.W.R.

N68-27495*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SATELLITE MEASUREMENTS OF PARTICLES CAUSING ZODIACAL LIGHT

Jose M. Alvarez *In its* The Zodiacal Light and the Interplanetary Medium 1967 p 123–129 refs (See N68-27475 16-30)

Explorer XVI and XXIII and Pegasus I, II, and III satellites, using pressurized-cell and capacitor-type penetration detectors, respectively, obtained measurements in near-earth space on the frequency of meteoroid penetration in metal test materials with thicknesses varying from 25 to 400 microns. Analysis of the penetration frequencies measured by these satellites gives a meteoroid population in space which is in agreement with results calculated by using zodiacal-light data. The satellite data refute the assumption that the number of particles in near-earth space varies as r^{-p} where r is the particle radius and p is a constant. The data and theoretical considerations indicate instead that the concentration of particles in near-earth space is given by $c(r) = 1.10 \times 10^{-16} r^{1.046-0.683 \log_{10} r}$ ($5.8\mu \leq a \leq 4.9$ mm) where r is particle radius in microns and c(r) is calculated per cm^3. The equation shows the concentration of particles in near-earth space is approximately 10^{-15} to 10^{-16}/cm^3 and that the smallest particles in the vicinity of earth are about 6 microns in radius, which agrees with the 3-micron radius calculated as the minimum considering solar radiation pressure. An average particle density of 0.2 g/cm^3 was assumed. Author

N68-27496*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

STUDY OF PARTICLES COLLECTED BY THE 1965 LUSTER ROCKET

N. N. Greenman, C. B. Gilpin, S. K. Asunmaa, and R. G. Ingersoll *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 131–146 refs (See N68-27475 16-30)
(Contract NASw-1401)

A luster micrometeorite-collecting rocket was successfully flown on November 16, 1965, during the Leonid meteor shower and collected for 206 seconds between altitudes of 63 and 144 kilometers. The primary objective was to test, by heat annealing, whether radiation damage distinguished extraterrestrial from terrestrial particles; the secondary objective was to measure the abundance, composition, and other properties of the micrometeorites. Heating tests were completed on one group of 58 particles and on 2 individual particles, and the one particle that showed evidence of possible radiation-damage annealing also showed some morphologic changes. Since all the studied particles could be contaminants, more particles must be studied before it can be determined whether radiation damage is a criterion for micrometeorites. The heat-produced morphologic changes discovered in this study may also prove to be important in distinguishing micrometeorites from contaminants. No chemical elements were identified in preliminary electron probe analyses. Eight individual particles and two groups of particles were found in a total scanned area of 36 mm^2 Author

N68-27497*# Dudley Observatory, Albany, N. Y.

PRELIMINARY MICROMETEORITE RESULTS FROM GEMINI 9 AND 12

C. L. Hemenway, D. S. Hallgren, and J. F. Kerridge (Birkbeck Coll., London) *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 147–153 refs (See N68-27475 16-30)
(Grant NsG-155-61)

Micrometeorite collection and cratering experiments were successfully exposed to the space environment during Gemini manned space flights. Preliminary results are presented, following an electron microscope examination of some thin nitrocellulose collection and penetration films. A study of cratering effects in polished stainless steel using optical microscopy and a Stereoscan electron microscope is also presented. Some evidence is advanced that discrepancies between satellite microphone and penetration data may be due to the fragile nature of a portion of the interplanetary dust population. Author

N68-27498*# Tel-Aviv Univ. (Israel).

PRELIMINARY RESULTS OF A MICROMETEOROID COLLECTION EXPERIMENT IN THE GEMINI PROGRAM

Uri Shafrir and Akiva Yaniv *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 155–160 ref (See N68-27475 16-30)

Preliminary analysis of a micrometeoroid collection experiment is discussed. The collection surfaces were exposed for approximately 17 hours to space environment at an altitude of about 250 km during the Gemini IX mission in May 1966. With the aid of optical and electron microscopy, surface phenomena, such as color changes of the copper grids, round holes in the 200-Å-thick formvar collecting film, and single-shadowed particles were observed. Some speculations as to the possible causes of these phenomena are presented. Author

N68-27499*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EVIDENCE OF DUST CONCENTRATION IN THE MESOSPHERE

O. E. Berg and L. Secretan *In its* The Zodiacal Light and the Interplanetary Medium 1967 p 161–163 refs (See N68-27475 16-30)

Data for cosmic dust impact were collected on Gemini XII and during two Aerobee flights; and, although each experiment received comparable exposures, the Gemini experiment yielded on probable impacts whereas the Aerobee experiments had a total of 18 probable impacts. (The term probable impacts refers to space perforations which were present in post-flight photometric scanning records only.) The entire Gemini exposure was at 290 km; the Aerobee exposures began at 65 km, rose to a peak of 170 km, and terminated on rocket descent at 80 km. It is considered possible that the impacts recovered from the rocket flights were inflicted by quasi-stationary particles in the region of the mesosphere impinging on the prepared surfaces, which were moving at a high velocity relative to the particles so that the metallic coating was perforated and detectable craters were produced. It is concluded that the region of the mesosphere may well harbor an interesting concentration of decelerated cosmic dust particles. Penetration parameters for soft, irregular microparticles at high velocities may vary wisely from accepted values derived from dissimilar laboratory models. M.W.R.

N68-27500*# Air Force Cambridge Research Labs., Bedford, Mass.

PARTICLE COLLECTION FROM THE LUSTER ROCKET

Robert A. Skrivanek *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 167–169 refs (See N68-27475 16-30)

A Project Luster Aerobee particle collection rocket was launched and recovered on November 16, 1965; and exposures began at 64 km through 144 km and continued during descent to 84 km. Optical microscopy and electron microscopy were used for the systematic scanning of the exposures; particle counts were found to be low. It is considered probable that the flux of cosmic dust particles measured by previous experiments was several orders of magnitude too high. Flux of particles of less than 0.5 micron cannot be accurately measured with presently existing techniques, and the contamination levels of particles in this size range must be reduced. For particles greater than 1 micron, contamination controls are adequate, but because the expected fluxes are rather low, either large areas must be examined or exposure times must be increased. The particles in this size range found on the present experiment are considered to constitute an upper limit. Reliable experimental data are difficult to obtain for particles between 0.5 and 1.0 micron; and increased exposure time, which is difficult to obtain with a small probe rocket, is considered the best approach. M.W.R.

N68-27501*# Academy of Sciences (USSR), Moscow.

PRELIMINARY RESULTS OF INVESTIGATIONS OF SOLID INTERPLANETARY MATTER IN THE VICINITY OF THE MOON

T. N. Nazarova, A. K. Rybakov, and G. D. Komissarov *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 171–172 Submitted for publication (See N68-27475 16-30)

Piezoelectric sensors on the Luna 10 satellite skin permitted the study of the impacts of meteoritic particles with masses 7×10^{-8} gram and larger at a particle velocity assumed to be 15 km/sec. Observations covered a region which represents an envelope 650 km in thickness surrounding the moon and is 355 km from the lunar surface except for a small part of the envelope that is not visible from the earth. The increased density of matter in the vicinity of the moon can be explained by assuming that the moon itself serves as a particle source; and, when meteoric bodies collide with the lunar surface, the resulting explosion ejects lunar rock mass which is many times greater than the mass of an impingement particle. If this hypothesis is correct, particles recorded by the lunar satellite will include those of lunar origin as well as a lesser amount of meteoric particles. M.W.R.

N68-27502*# Washington Univ., Seattle.

ELEMENTAL ABUNDANCES IN THE INTERPLANETARY DUST

Paul W. Hodge and Frances W. Wright (Smithsonian Astrophys. Obs.) *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 173–176 refs (See N68-27475 16-30)

Data on the elemental abundances of particles believed to be interplanetary in origin are derived from chemical analyses of several hundred small particles collected in remote regions. The agreement with general cosmic abundances of the heavier elements, with a few exceptions, is good. Author

N68-27503*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

SPACE DENSITY OF RADIO METEORS

Richard B. Southworth *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 179–188 refs (See N68-27475 16-30)

(Contracts NAS9-4875; NSR-09-015-033; Grant NsG-158; Contract AF 19(628)-3248)

The space-density distribution of dust in the solar system is estimated from the orbits of approximately 13000 radar meteors. Approximate corrections are made for unobservable classes of orbits and for other observational selection effects. Within the limits 0.1 to 10 AU, the space density decreases monotonically outward from the Sun. The distribution in heliocentric latitude has a very broad maximum centered on the ecliptic and a deep minimum over the ecliptic poles. There is no evidence for any substantial enhancement of density in the asteroid belt. The distribution shows the effects of planetary perturbations and collisional destruction. Author

N68-27504*# Academy of Sciences (USSR), Moscow. Astronomical Council.

THE ORBITS OF METEOR BODIES AND THE ORIGIN OF THE HARD COMPONENT OF THE INTERPLANETARY MEDIUM

B. L. Kashcheyev and V. N. Lebedinets *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 189–199 refs (See N68-27475 16-30)

A semimajor axis distribution of radio meteor orbits is graphed; as are eccentricity, perihelion, and inclination distributions of the same orbits. Data on 2529 orbits of weak photographic meteors was compared with the distribution of 144 orbits of bright photographic meteors; and orbits were calculated for 12,500 meteors, including 3500 meteors belonging to meteor streams. Mean dimensions of meteor orbits decreased steadily with meteor masses, while the eccentricity distributions of radio meteors and photographic meteors were found to be essentially the same. Distributions of perihelion distances are substantially different; the distribution function of radio meteors decreases steadily, while that of photographic meteors steadily increases. A strongly pronounced concentration near the ecliptic plane is characteristic of photographic meteors, and substantially less pronounced in the case of radio meteors. Stream meteors rarely have very small size orbits, while almost one-half the sporadic meteors do. The origin of meteor substance is discussed, including disruption of comets, disintegration of asteroids, and penetration of hard particles into the inner solar system regions from the outer periphery under the action of the Poynting–Robertson effect. M.W.R.

N68-27505*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

ORBITAL DISTRIBUTIONS OF METEORS OF LIMITING MAGNITUDE +6 OBSERVED FROM THE SOUTHERN HEMISPHERE

Carl S. Nilsson *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 201–211 refs (See N68-27475 16-30)
(Contract NSR-09-015-033)

A radio survey of orbits of meteors of limiting magnitude +6 was made at Adelaide, South Australia, during 1961. Each orbit has been weighted for observational and astronomical selection, and the distributions of 1900 orbits are compared with those of other surveys, particularly with those of the faint photographic survey of McCrosky and Posen (1961). The distributions for stream orbits and sporadic orbits are given separately. The two most noteworthy distributions are those with perihelion distance and longitude of perihelion. The latter shows evidence of Jupiter alignment for the sporadic meteor orbits; this evidence, however, still does not differentiate between an asteroidal of cometary source. Author

N68-27506*# Rensselaer Polytechnic Inst., Troy, N. Y.

SMALL PARTICLES IN SPACE

J. Mayo Greenberg *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 215–223 refs Sponsored by NASA and NSF (See N68-27475 16-30)

The scattering of radiation by small spherical and nonspherical particles is discussed in relationship to studies of interstellar and interplanetary grains. A survey is made of the theories of the origin of the interstellar particles and their physical interactions with the gas atoms and radiation in space. Theoretical and observational evidence is presented for the various interstellar-grain models. The present state of affairs seems to indicate that the interstellar particles are at least optically similar to the interplanetary particles responsible for producing the zodiacal light. A preliminary investigation is made to show the possible kinds of orientation appropriate to nonspherical interplanetary particles. Author

N68-27507*# Melpar, Inc., Falls Church, Va.

ANALYSIS OF ALL AVAILABLE ZODIACAL-LIGHT OBSERVATIONS

R. S. Powell, P. E. Woodson, III, M. A. Alexander, R. R. Circle, A. G. Konheim et al *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 225–241 refs (See N68-27475 16-30)
(Contracts NASw-1198; NASw-1206)

A model of the interplanetary-dust ensemble is derived which explains many of the inconsistencies in the zodiacal-light observations. It is shown that the number density of particles is nearly independent of distance from the sun in the region between Mercury and Mars but is possibly zero beyond Mars. Further, it is shown that the size distribution of the interplanetary dust changes slightly with time and distance from the sun. Finally, it is shown that the ensemble consists of particles with radii less than 1.1 micron. A few larger particles certainly exist but they do not affect the zodiacal light. The electron density in the region beyond Mercury is arbitrary. Author

N68-27508*# California Univ., Los Angeles.

SOME MODELS OF THE ZODIACAL CLOUD

L. H. Aller, G. Duffner, M. Dworetsky, D. Gudehus, S. Kilston et al *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 243–256 refs Sponsored by NASA (See N68-27475 16-30)

Simplified heliocentric models that attempt to reproduce the observed polarization, brightness, and color distribution in zodiacal light were investigated. Calculation of the Mie coefficients needed to obtain the scattering function are discussed, along with the adoption of an assumed particle size distribution for zodiacal cloud and the evaluation of the resultant scattering function. Radiation pressure effects were evaluated and the size of particles that can be retained in the solar system was determined. Identification was made of the influence of each model parameter on the results and the specifications of observations needed to determine the unique properties of interplanetary material. Detailed formulations are included for determining the monochromatic surface brightness of zodiacal light, as well as for the predicted colors and polarizations for some of the models. It appears that a large number of models can be made to fit the observations about equally well. Mie theory models that come close to fitting the observed polarization and intensity curves suggest that on the average the zodiacal light is about 0.2 magnitude bluer than the sun. M.W.R.

N68-27509*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

PHASE FUNCTION OF THE ZODIACAL CLOUD

Richard B. Southworth *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 257–270 refs (See N68-27475 16-30)

Smith, Roach, and Owen's zodiacal-light photometry was analyzed for the phase function and distribution of the particles. It was assumed that (1) there is a unique phase function, (2) the space density is the product of a distribution in heliocentric latitude and another in radius vector, and (3) all the observed light is scattered by interplanetary particles symmetrically distributed about the sun, except for the enhancement at 65° elongation (possibly this is double scattering by ice in the high atmosphere). Various distributions in radius vector are tried, each yielding a phase function and a latitude distribution, and a predicted zodiacal-light distribution. Good fits to the observations are found with radial-density distributions similar to that found from radar meteors; these also yield latitude distributions comparable to the meteor distribution. For scattering angles above 60°, the phase functions resemble a Lambert law, except for an extra peak near 180°, which could be caused by particle roughness. Author

N68-27510*# Max-Planck-Institut fur Physik und Astrophysik, Munich (West Germany).

ON OPTICAL MODELS APPROXIMATING OBSERVATIONS OF THE ZODIACAL LIGHT OUTSIDE THE ECLIPTIC

R. H. Giese and C. V. Dziembowski *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 271–276 refs (See N68-27475 16-30)

Starting with Blackwell-Ingham and Elsasser models, which fit Weinberg's observations in the ecliptic plane, optical models were developed for approximating the zodiacal light outside the ecliptic. Average scattering functions as defined by Giese and Siedentopf were used to represent the typical properties of one particle out of a mixture of spherical properties ranging from the lowest to an upper size parameter. It is found that as long as computations and observations are restricted to the ecliptical plane, no reliable distinction can be made between the Rayleigh and the metallic-particle models presented. Haleakala data obtained in 1966 were better approximated by the metallic-particle model, possibly because it produced a steeper decrease of brightness from 0 to 20° in the region $\epsilon < 60^\circ$ due to the steeper decrease in both scattering and density-distribution function. The special examples presented are not considered to give the real distribution of interplanetary dust particles, but rather demonstrate the general features of the models. M.W.R.

N68-27511*# Max-Planck-Institut fur Physik und Astrophysik, Munich (West Germany).

THEORETICAL CONSIDERATIONS OF SMALL PARTICLES IN INTERPLANETARY SPACE

L. Biermann *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 279–286 refs (See N68-27475 16-30)

The lifetime of dust particles in interplanetary space as a function of the particles' radius *a*, the composition, and the shape is discussed for the size range of 0.01 $\mu \leq a \leq$ several μ, for which cometary origin is assumed to predominate. Near both the upper and lower limits, the lifetime becomes directly proportional to *a*, but with coefficients differing in the ratio of approximately 1000 to 1. In the middle range ($0.03 < a < 0.3$) the lifetime is determined essentially by radiation pressure and gravity; it is approximately independent of *a* and equal to 10^7 seconds. The sharp drop of the lifetime by ≥ 3 powers of 10 from the upper range, where the Poynting–Robertson effect and (possibly) sputtering dominate, to the middle range is somewhat smoothed out by the initial conditions given for particles of cometary origin, by differences of the composition and optical properties and of the particle shapes, and (possibly) by electromagnetic effects, provided a purely statistical increase of the particle energy with time can be assumed. The transition from the middle to the lower range, in which electromagnetic effects dominate and cause spherical particles with $a \approx 0.01\ \mu$ to escape in $\leq 10^5$ seconds, is continuous. Author

N68-27512*# Landessternwarte auf dem Koenigstuhl, Heidelberg (West Germany).

DYNAMICS OF SUBMICRON PARTICLES ($A < 10^{-10}$ CM) IN INTERPLANETARY SPACE

Thomas Schmidt and Hans Elsaesser *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 287–289 refs (See N68-27475 16-30)

The possibility of submicron particles existing in the interplanetary space was investigated to determine if the polarization of zodiacal light could be partially due to light scattering by such particles. Sampling experiments carried out during the past few years indicate the existence of particles with diameters of less than 10^{-5} cm. Radiation and particle pressure are discussed; as are the Poynting–Robertson effect, the Lorentz force of the interplanetary magnetic field, and the circumterrestrial dust cloud. M.W.R.

N68-27513*# Rose Polytechnic Inst., Terre Haute, Ind.

ELECTROSTATIC POTENTIAL OF A COSMIC DUST PARTICLE

John W. Rhee *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 291–298 refs (See N68-27475 16-30)
(Grant NSF GY-670)

An attempt has been made to compute the equilibrium potential of a cosmic dust particle in interplanetary space. The equilibrium potential is determined by the balance of the photoelectrons and thermal plasma only. The contribution to the potential from the protons is shown to be small and can be neglected in interplanetary space. The preliminary data seem to indicate that the maximum potential is 6.6 volts at 1 AU, 5.7 volts at 2 AU, and 5.3 volts at 3 AU. The potential must be of the same order of magnitude at the other distances. Author

N68-27514*# Kitt Peak National Observatory, Tucson, Ariz.

DYNAMICS OF INTERPLANETARY DUST PARTICLES NEAR THE SUN

Michael J. S. Belton *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 301–306 refs *Its* Kitt Peak Natl. Obs. Contrib. No. 237 (See N68-27475 16-30)

The majority of smaller dust particles are not destroyed by vaporization in the neighborhood of the sun that is generally considered as the primary sink for zodiacal dust particles. After approaching a certain minimum distance from the sun under the influence of the usual drag forces, the onset of vaporization stabilizes the oribts of the particles and then causes them to move out into interplanetary space. The grains are reduced in size, but do not in general become so small that radiation pressure overcomes gravity. The interaction of the electrically charged grains with the magnetized interplanetary gas is included in the dynamical treatment. First-order perturbation theory (variation of elements) is used to make quantitative estimates of the effects of Lorentz forces on the orbits of the particles. The observed component of the interplanetary magnetic field perpendicular to the ecliptic has important consequences for the zodiacal particles if its direction is stable over time scales comparable with the period of the solar cycle. Author

N68-27515*# Cornell Univ., Ithaca, N. Y.

THE CLOUD OF INTERPLANETARY BOULDERS

Martin Harwit *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 307–313 refs (See N68-27475 16-30)
(Contract NSP-33-010-026; Grants NsG-382; NSF GP-1338)

Density of boulders (roughly 10-meter-sized objects) in interplanetary space was evaluated. Such bodies cannot be directly observed and the most direct evidence comes from impacts on the earth. The most plausible density, consistent with various types of data, is $\approx 4 \times 10^{-28}$ cm^{-3}. This is about three orders of magnitude higher than the density usually quoted. The difference arises because the boulders are considered to have orbits of low eccentricity and their approach rate toward the earth is slow because the weak Poynting–Robertson effect is the only means by which the boulders are impelled into orbits of smaller diameter. The low orbital eccentricity is consistent with an asteroidal origin of boulders. The unusually high concentration of boulders postulated here can indirectly produce interplanetary dust at a rate high enough to compensate the Poynting–Robertson losses. The high concentration of boulders can also explain the observed rate of splitting among parabolic comets and is consistent with the observation that these comets split near the ecliptic plane. Author

N68-27516*# Bellcomm, Inc., Washington, D. C.

COLLISIONAL MODEL OF METEOROIDS

J. S. Dohnanyi *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 315–319 refs (See N68-27475 16-30)

A collisional model of meteoroids was formulated assuming that all objects collide with a certain average relative velocity, all masses are spherical and have the same density and other material properties, and all collisions are center to center (i.e. impact parameter is zero). These assumptions were introduced to render the mathematics tractable without seriously compromising physical reality. Other assumptions were also made to permit the description of mass distribution of a system of particles undergoing collisions and fragmentation at relative speeds in the high or hypervelocity range. Observed values of the population index versus the mass of interplanetary particles as reported by various investigators are shown; and some of these values are considered consistent with the steady-state distribution model presented. M.W.R.

N68-27517*# Odessa Polytechnic Inst. (USSR).

LIGHT SCATTERED BY THE EARTH'S DUST CLOUD

N. B. Divari *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 321–331 refs (See N68-27475 16-30)

The intensity of sunlight scattered by the earth's dust cloud was calculated on the basis of different suppositions relating to the distribution of dust in the vicinity of the earth. Brightness of zodiacal light is shown for various angles and space density for several models is tabulated. It is considered difficult to determine to what extent the space density of submicron dust is real because no direct measurements can be made of such particles; and the importance of establishing the dependence of polarization degree on scattering angle for submicron particles is stressed. M.W.R.

N68-27518*# Landessternwarte auf dem Koenigstuhl, Heidelberg (West Germany).

THE POSSIBILITY OF DUST CONCENTRATION NEAR THE EARTH

Thomas Schmidt *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 333–336 refs (See N68-27475 16-30)

Taking into account the radiation and corpuscular pressure as well as the radiation and corpuscular Poynting–Robertson effect, the differential equation of particle motion in dust near the earth or its orbit was solved numerically by the Runge–Kutta method. Only particles greater than 10^{-4} cm were considered because they are not seriously affected by Lorentz forces of interplanetary magnetic fields. Corpuscular pressure for these particles is negligible although the corpuscular Poynting–Robertson effect is not. Attention is given to the radiation pressure and the Poynting–Robertson force, capture orbits of the earth's gravitational field, and the dust ring near the earth's surface. Computations were made on a Siemens 2003 computer, which was not fast enough to follow a sufficient number of particle orbits from the first influence of the earth until the final passing into the inner part of the solar system. M.W.R.

N68-27519*# California Univ., Los Angeles.

THE ZODIACAL LIGHT AND EARTH-ORBITING DUST

S. J. Peale *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 337–342 refs (See N68-27475 16-30)

Dynamical and observational properties of a geocentric dust cloud are discussed and compared with ground-based observations of the zodiacal light in the ecliptic plane. While recent observations by themselves make the geocentric hypothesis less likely, the restrictions place on the characteristics of geocentric dust by theoretical and numerical work in conjunction with these observations essentially destroy the hypothesis of a large geocentric contribution to the zodiacal light. Difficulties with the hypothesis of a large geocentric contribution to the zodiacal light include the capture of small particles into geocentric orbit, and measurements of the surface brightness of zodiacal light off the ecliptic plane are not compatible with a large contribution. It is noted that at the time of a solar eclipse, the F corona is observed to increase in brightness at an ever-increasing rate as the line of sight approaches the lunar limb, and that this observation eliminates any substantial contribution to the F corona by dust particles with the lunar orbit. M.W.R.

N68-27520*# Douglas Aircraft Co., Inc., Huntington Beach, Calif.

THE METEOROID ENVIRONMENT NEAR THE ECLIPTIC

John K. Wall *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 343–357 refs (See N68-27475 16-30)

A new model of the distribution of solid particles near the ecliptic was developed in which the particle distribution function f is expressed as the product of three functions in the form $f = f_s f_v f_m$ where f_s is the distribution with respect to distance from the sun, f_v is the distribution with respect to particle speed, and f_m is the distribution with respect to particle mass. The spatial distribution function is evaluated by combining Mariner 4 micrometeoroid flux data with the observed spatial distribution of the asteroids, corrected for the variation in the size of the smallest observable asteroid with distance from the sun. The velocity distribution function is evaluated from meteor data, corrected for the nonequilibrium radiation from the gas cap. The mass distribution function is evaluated by combining zodiacal light data corrected for the spatial distribution of particles, microphone, and penetration meteoroid detector data; reinterpreted optical and radio meteor data; and the size distributions of meteorites, lunar craters, and the asteroids. It is found that the near-earth particle flux is $10^{-13.8} m^{-0.9}$ particles/m^2sec when the particle mass m is in grams. Author

N68-27521*# Stanford Univ., Calif.

INTERPLANETARY ELECTRON CONCENTRATION AND VARIABILITY MEASUREMENTS WITH PIONEER 6 AND 7

H. T. Howard and R. L. Koehler *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 361–364 refs (See N68-27475 16-30)

Phase and group path data were obtained from the radio propagation experiments aboard Pioneers 6 and 7, from which harmonically related phase-modulation signals near 50 and 425 MHz were transmitted from a ground-based 150-ft parabolic dish and received by whip antennas on the spacecraft. While the method used is extremely sensitive to changes in electron content, it does not provide an absolute number; total content is deduced by comparing modulation phase as transmitted from the ground with as it is received in space. The first six months of the Pioneer 6 and 7 orbits are shown, and interplanetary plus protonosphere integrated electron content is graphed along with evidence of extremely high electron content and normal electron content. It is concluded that a traveling stream of solar plasmas with a number density of 5 or 6 times that of the quiet interplanetary gas was observed moving through space at near solar wind velocities. M.W.R.

N68-27522*# Los Alamos Scientific Lab., N. Mex.

SATELLITE OBSERVATIONS OF THE GENERAL CHARACTERISTICS AND FILAMENTARY STRUCTURE OF THE SOLAR WIND

I. B. Strong, J. R. Asbridge, S. J. Bame, and A. Hundhausen *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 365–372 refs Sponsored by AEC and AF (See N68-27475 16-30)

Solar wind observations made by the electrostatic analyzers on four separate Vela satellites are reported; with the Vela 2 type analyzer rotating 5.8° during each counting period and consisting of a pair of concentric hemispherical deflection plates with small entrance and exit apertures at opposite ends. Ions with a narrow range of energy per unit charge are translated into the exit aperture and counted with close to 100% efficiency by an electron multiplier. Directional properties, velocity, and temperature for the solar wind are discussed; and elementary structure in the solar wind is considered. M.W.R.

N68-27523*# Miami Univ., Coral Gables, Fla.

NATURE AND ORIGIN OF ZODIACAL DUST

S. Fred Singer and Lothar W. Bandermann *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 379–397 refs (See N68-27475 16-30)

Dust measurements in ocean sediments, near the earth, in the upper atmosphere, and from zodiacal light in interplanetary space are considered in an attempt to define zodiacal dust and its physical and orbital parameters. Possible modifications in a dust particle as it goes through interplanetary space are described, and various means of measuring dust in the four media are discussed. Attention is given to the present interplanetary dust cloud, including altitude variations, the interpretation of satellite data, morning–evening asymmetry, and analysis of the zodiacal light isophotes. Physical effects and dynamical perturbations and the alterations in interplanetary dust are considered; with specific attention to ejection by radiation pressure, orbit modification by radiation effects, sputtering, electromagnetic effects, and planetary perturbations. The influence of these perturbation forces is discussed in terms of various models for the origin of zodiacal dust. M.W.R.

N68-27524*# National Research Council of Canada, Ottawa (Ontario).

OBSERVATIONAL EVIDENCE OF THE METEORITIC COMPLEX

Peter M. Millman *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 399–407 refs (See N68-27475 16-30)

Physical parameters related to the present character, together with its past and future development, are considered for the meteoritic complex which includes the small solid particles in interplanetary space ranging in size from dust grains bigger than the largest molecules up to objects of the smallest asteroid class. Observational areas that provide data relating to these parameters are impact craters, meteorites, meteor photography, radio meteor studies, penetration and cratering records, interplanetary dust collecting, acoustic and photometric impact counting, and zodiacal light observations. M.W.R.

N68-27525*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

ON MAINTAINING THE METEORITIC COMPLEX

Fred L. Whipple *In* NASA, Washington The Zodiacal Light and the Interplanetary Medium 1967 p 409–426 refs (See N68-27475 16-30)
(Contracts NAS9-4873; NSR-09-015-033; AF 19(628)-3248)

The meteoritic influx on the earth is derived from measurements of penetration of space vehicles, radio and photographic meteors, meteorite falls, Apollo asteroids, lunar craters, and comets. The total flux is about 2×10^{-16} g/cm^2-sec on the surface of a corresponding nongravitating sphere. Such a cloud is self-destructive by collisions. It requires some 10 times the continuous contribution that the Poynting–Robertson effect alone would demand to maintain the zodiacal light and cloud, that is, some 10 tons per second for quasi-equilibrium. This observational model is consistent with the etching rates observed on stone and iron meteorites and on photographic meteoroids. Various observational and theoretical facts indicate that the cloud up to masses of about 10^5 grams is maintained by "live" comets. "Half-baked" asteroids, however, may compete with comets in contributing to the brightest fireballs. The stony meteorites may be maintained by collisional spallation from earth-crossing asteroids induced by smaller bodies, the Apollo asteroids being derived from the asteroid belt by the gravitational effects of Mars. The cometary meteoritic complex of smaller particles, carrying most of the mass, has a mean lifetime of some 1.7×10^5 years. Certain puzzles remain in the orbital properties of the Apollo asteroids and of iron and stone meteorites. Author

N68-27572*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRELIMINARY RESULTS ON THE LUNAR GRAVITATIONAL FIELD FROM ANALYSIS OF LONG PERIOD AND SECULAR EFFECTS ON LUNAR ORBITER 1

W. Thomas Blackshear, Harold R. Compton, and James R. Schiess 1967 25 p refs Presented at NASA Seminar on Guidance Theory and Trajectory Analysis, Cambridge, Mass., 31 May–1 Jun. 1967
(NASA-TM-X-60127; L-5722) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The Doppler tracking data from the first lunar satellite established by the United States, Lunar Orbiter I, have been used to determine the long-period and secular variations in the Keplerian orbital elements. These variations have been analyzed to determine a preliminary set of coefficients in the expansion of the lunar gravitational field in terms of spherical harmonics. The methods used to determine the long-period and secular variations in the orbital elements and to reduce these variations to determine the gravitational field coefficients are presented. Also presented in this paper are time histories of the orbital elements, Doppler residual plots, curves showing the fits to the mean orbital elements and a preliminary estimate of a set of gravitational field coefficients. Author

N68-27642*# Lincoln Lab., Mass. Inst. of Tech., Lexington.

RADAR STUDIES OF THE MOON, VOLUME 2 Final Report

13 Jun. 1968 104 p refs
(Contract NSR-22-009-106)
(NASA-CR-95218) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The theories involved in supersynthesis and delay-Doppler methods of mapping the radar echo power distribution across the lunar surface are discussed, and the necessary ephemeris calculations are described. With the supersynthesis technique, carried out at 23 cm wavelength using the L-band radar facility, consecutive measurements of the CW lunar echo power spectrum were obtained over a period of many hours. During the interval of observation, the position angle of the apparent axis of lunar rotation, measured with respect to the projection of the lunar polar axis, varied through an angle of 180°. Combination of the spectral information obtained yielded an effective resolution of about 100 km on the lunar surface. Delay-Doppler mapping requires analysis of the returned echo power simultaneously in range as well as frequency. Only measurements at 3.8-cm wavelength were possible, using the Haystack radar facility. The method is considered relatively effective, yielding an estimate of the distribution of radar reflectivity with a fine-grained surface resolution of between 1 and 7 km after only about 15 minutes. Computer requirements and data reduction techniques are also described. M.G.J.

N68-27644*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SUDDEN COMMENCEMENT ASSOCIATED DISCONTINUITIES IN THE INTERPLANETARY MAGNETIC FIELD OBSERVED BY IMP 3

Harold E. Taylor Jun. 1968 30 p refs
(NASA-TM-X-63246; X-616-68-239) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The magnetic field measurements made by the magnetic field experiment on the IMP 3 (Explorer 28) spacecraft have been examined at the time of geomagnetic s.s.c. events. 36 such events occurred while IMP-3 was in the interplanetary medium during 1965, 66 and 67 and have been analysed. Of these events 8 must have been tangential discontinuities, 2 are either tangential discontinuities or rotational discontinuities and 26 are possible shock waves. These 26 possible shocks have similar magnetic signatures: an increase of 20% or more in the magnetic field magnitude and a relatively small (always less than 90°) change in direction. The larger s.s.c. events were more likely to be caused by possible shocks while the smaller events were often associated with tangential discontinuities. It was possible to associate solar flares with 14 of the 26 possible shock events. Of these 14 a reliable orientation was deduced for 8 events. Author

N68-27652*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRELIMINARY RESULTS FROM THE LUNAR ORBITER SELENODESY EXPERIMENT

William H. Michael, Jr. [1967] 42 p refs Presented at the NASA Inst. for Space Sci. Colloq., New York, 18 May 1967
(NASA-TM-X-60123) CFSTI: HC $3.00/MF $0.65 CSCL 22A

To determine the components of the lunar gravitational field, techniques were developed for analyzing Lunar Orbiter tracking data. These included the methods of weighted least squares, differential corrections, and numerical integration, which were used to calculate the values for a set of parameters. Five separate data arcs, based on tracking data from the first three Lunar Orbiter spacecraft, were used, and lunar gravitational field coefficients were computed. The data are compared with previous known information, and the results are applied to orbit prediction, lunar topography, and the determination of some physical properties of the moon. A.L.

N68-27672 California Inst. of Tech., Pasadena.

INFRARED 8–13μ SPECTROSCOPY OF THE MOON AND SOME COLD SILICATE POWDERS

Alexander Franklin Hermann Goetz (Ph.D. Thesis) 1967 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-6453

Laboratory investigations were made of the spectral emission properties of a limited number of silicate powders in vacuum and surface termperatures of 180-240°K. The effect on the emission spectrum of mineral composition, powder grain-size, surface contamination and thermal gradient were studied. The low sample surface temperature enhanced the spectral contrast of quartz but had little effect on spectra of rock materials. In general, there was a decrease in spectral contrast with decreasing sample grain-size. Differential 8-13μ spectroscopy of 22 lunar points, spanning the major types of lunar features, was undertaken to determine if compositional differences or age are evidenced in the 8-13μ emission spectra of the features. A method was devised to remove precisely the atmospheric absorption and allow the integration of many spectra in order to reduce uncertainties caused by atmospheric absorption fluctuations and detector noise. Twenty of the 22 points showed no spectral differences greater than 1%. Dissert. Abstr.

N68-27678*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE AVERAGE MAGNETIC FIELD CONFIGURATION OF THE OUTER MAGNETOSPHERE

D. H. Fairfield Jun. 1968 32 p refs
(NASA-TM-X-63241; X-616-68-197) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Over 1500 hours of data from the satellites IMP 1, 2 and 3 have been used to study the configuration of the magnetic field in the outer magnetosphere between 5 and 18 R_E. Hourly average field vectors were projected in the solar magnetic equatorial plane and in 24 meridian sections corresponding to each hour of local time. The plots show the sweeping back of the field toward the tail and the dawn and dusk transition from compressed dayside field lines to extended night side field lines. Constant B contours in the equatorial plane were constructed and flux conservation was used to establish a quantitative relationship between the equatorial crossing point of an outer magnetosphere field line and the latitude of its earth intersection. A contour diagram in the equatorial plane designating the latitude of field line origin permits the mapping of low altitude phenomena to the equatorial plane and vice versa. Author

N68-27687*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE LOWER IONOSPHERE OF MARS

A. C. Aikin Apr. 1968 29 p refs
(NASA-TM-X-63237; X-615-68-122) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The ionization of the Martian atmosphere below 100 km was studied in the context of recent data on the atmosphere and ionosphere on the planet. Suggested sources of ionization include: solar ultraviolet and x-radiation, cosmic rays, meteors, radioactive material within the atmosphere and radioactivity of the surface, the solar wind, and protons originating from solar flares. Loss processes, including charge rearrangement, dissociative recombination of ions and electrons, and negative ion formation are detailed. Possible importance of the negative ion CO_4^- is discussed. It distribution will depend on the O_2 content of the atmosphere as well as the distribution of O and CO. CO^- and CO_3^- may also be presented in the ionosphere. It is shown that combination of the solar photoionization rate with that due to comsic radiation will lead to an ion density minimum. The magnitude of the ion density and location of the minimum will depend on the atmospheric model chosen, solar activity, and solar zenith angle as well as such factors as the presence of particulate matter and meteor ionization. Author

N68-27696*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRELIMINARY RESULTS ON THE GRAVITATIONAL FIELD OF THE MOON FROM ANALYSIS OF LUNAR ORBITER TRACKING DATA

William H. Michael, Jr., Robert H. Tolson, and John P. Gapcynski [1967] 20 p refs Presented at the Am. Geophys. Union Ann. Meeting, Washington, D. C., 17–20 Apr. 1967
(NASA-TM-X-59860) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Tracking data from the Lunar Orbiter spacecraft are being analyzed to define the coefficients in the expansion of the lunar gravitational field in terms of spherical harmonics. The primary basis for the analysis of the gravitational components and other parameters of interest, is a special purpose computational approach using numerical techniques and the procedures of differential correction and weighted least squares. A preliminary set of gravitational field coefficients is presented, and the contributions and possible shortcomings of this set are discussed. Contour plots of lunar topography, as derived from the gravitational field results, are presented. With respect to the mass distribution in the moon, the initial indications are that the moment of inertia about the polar axis is greater than that which would be expected on the basis of a homogeneous density distribution. Author

N68-27703*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.

THE ELECTRON PRESSURE IN THE ATMOSPHERES OF LATE-TYPE DWARFS

Robert S. Kandel May 1968 11 p refs Supported in part by NAS-NRC
(NASA-TM-X-61134) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Possible over-ionization of potassium and sodium in the very coolest stars that leads to an excess of electron pressure and higher H^- opacity should be accounted for in studying the atmospheres of late-type K6-M2 dwarfs. Profile of the λ 4227 line in several late-type dwarfs was studied with the Coudé spectrograph of the 193 cm telescope; and the profiles hardly vary among five such stars. Profiles predicted by model atmospheres were far broader than these observations; and the discrepancy becomes greater as models with lower affective temperatures are used. M.W.R.

N68-27718# Smithsonian Astrophysical Observatory, Cambridge, Mass.

VARIABLE STARS: THREE INVESTIGATIONS

S. A. Zhevakin and D. A. Frank-Kamenetskii 20 Nov. 1967 46 p refs Transl. into ENGLISH from Russian *Its* No. 11

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N68-27719# Smithsonian Astrophysical Observatory, Cambridge, Mass.

A DISCRETE MODEL OF A STAR (OSCILLATION AND EXPLOSION)

S. A. Zhevakin *In its* Variable Stars: Three Invest. 20 Nov. 1967 p 3–26 refs (See N68-27718 16-30)

We trace the construction and investigation of a nonconservative discrete stellar model, which is relevant to the study of such stellar processes as oscillations and explosions. We show that this model resembles in most features the continuous models that are discussed in the astrophysical literature. As an example, we study the auto-oscillation model with one degree of freedom, maintained by the operation of the familiar mechanism of vibrations, connected with the release of energy by thermonuclear reactions; we show that these reactions cannot be the direct cause of stellar oscillations. Author

N68-27720# Smithsonian Astrophysical Observatory, Cambridge, Mass.

PULSATIONS NEAR STELLAR SURFACES

D. A. Frank-Kamenetskii *In its* Variable Stars: Three Invest. 20 Nov. 1967 p 28–33 refs (See N68-27720 16-30)

An approximate expression for nonadiabatic pulsations in stars is derived by breaking up the star into a central zone with adiabatic oscillations and a peripheral zone where curvature and energy emission are neglected. Obtained formulas for the state of the material during the pulsation process and the flux of heat across each unit area during pulsation are then used to deduce the correlation between amplitude and period of vibration on one side, and between amplitude and asymmetry on the other. Obtained calculated values agreed with empirical data within limits of comparison precision. G.G.

N68-27721# Smithsonian Astrophysical Observatory, Cambridge, Mass.

ON THE AUTO OSCILLATIONS OF ONE CEPHEID MODEL

S. A. Zhevakin *In its* Variable Stars: Three Invest. 20 Nov. 1967 p 35–44 refs (See N68-27718 16-30)

Auto-oscillating behavior of a Cepheid star is studied by constructing a stellar model with a stable center from ordinary differential equations that describe the star as an elastic weightless gas surrounded by a spherical shell. A perturbation method is used to introduce the nonlinear system of oscillations and it is shown that auto-oscillation develops when excited fluctuations with disturbance of the Routh–Gurwitz condition develop a stable closed cycle. G.G.

N68-27723# Defence Research Board, Ottawa (Ontario). Defence Scientific Information Service.

THE CHARACTER OF METEORITE BREAK-UP

P. B. Babadzhanov and Ye. N. Kramer May 1968 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 177, no. 5, 1967 p 1043–1046
(T-500-R) CFSTI: HC $3.00/MF $0.65

Processes of meteorite evaporation, luminescence, and fragmentation were studied from the instantaneous photographs of 89 meteors; and results are included for two meteorites. Values for a Perseid meteorite, with initial velocity of 60.6 km/sec and mass somewhat over 20 g, are given in relation to altitude for velocity, deceleration, mass, and coefficient of ablation. Increasing coefficient of ablation is evidence of progressive meteorite fragmentation, and comparison of observed and theoretical decelerations indicate, however, that the parent body broke up into relatively large fragments. Ordinarily break-up of a meteorite into fragments occurs after its flare-up into luminescence because of the sudden evaporation of the molten surface layer. The liberation of internal energy via the evaporation of volatile inclusions appeared to be involved, however, in the break-up of meteor no. 407 observed at Odessa. One of the fragments was moving considerably faster than the original mass immediately after the break-up. M.W.R.

N68-27768# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PHOTOGRAPHIC SPECTROPHOTOMETRY OF H AND K Ca II LINES IN THE CENTER OF THE DISK AND IN THE TOTAL FLUX OF THE SUN [FOTOGRAFICHESKAYA SPEKTROFOTOMETRIYA LINIY H I K Ca II V TSENTRE DISKA I V SPEDNEM PO DISKU SOLNTSA (V POLNOM POTOKE)]

O. A. Mel'nikov and S. S. Zhuravlev *In its* Herald of Leningrad Univ., Vol. 18, No. 19, 1963 1 Jun. 1967 p 165–171 refs (See N68-27756 16-23)

An analysis is presented of spectrograms of the total solar radiation flux obtained by the photographic method, and spectrograms obtained by photoelectric photometry. The dispersion coefficient of the 3933 Å K line of Ca (II) and the absorption coefficient for the continuous solar spectrum were computed. Line–wing profiles were determined for three values for the number of atoms in one gram of solar matter (5.0 × 10^{17}, 1.0 × 10^{18}, and 2.5 × 10^{18}) on the basis of the ratio of the dispersion and absorption coefficients obtained. The line K of the total solar radiation flux is wider at the wings and narrower in the middle than the same line obtained from the radiation of the center of the solar disk. Author

N68-27873*# Fairchild Camera and Instrument Corp., Syosset, N. Y. Space and Defense Systems Div.

MARTIAN ORBITAL PHOTOGRAPHIC STUDY Technical Summary Report

R. Bashe and S. Kennedy 30 Dec. 1967 360 p refs
(Contract NAS8-21025)
(NASA-CR-61854; FSDS-S/T-C67-3) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A comprehensive study program aimed at achieving a more precise definition of realistic Martian orbital photographic experiment objectives and instrumentation techniques for the early orbital missions is described. Photographic experiment objectives, photo sensor subsystems, and system tradeoff considerations are presented. A detailed review of those particular areas of scientific inquiry concerning the planet Mars which can be investigated by means of orbital photographic sensors is given. Specific areas for high resolution Martian coverage are suggested. The relationships between relevant orbital parameters and mission constraints to the imaging system design criteria are developed. Current state-of-the-art and realizable capabilities of optical subsystems and various film, electro-optical and other sensor devices are discussed in detail. System coverage, resolution, sensitivity, format size, multispectral capability and stereo capability are evaluated. Also considered are system assessments of data acquisition, conversion and transmission requirements and techniques. The results of photo system tradeoff studies are presented. Author

N68-27888# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

VELOCITY OF LARGE METEORS IN THE EARTH'S LOWER ATMOSPHERE

Albert D. Anderson Jun. 1968 23 p refs
(LMSC-6-78-68-22)

Information available at the present time concerning the velocity of large meteors in the earth's atmosphere is very scarce and unreliable, mainly because it is not possible to carry out systematic measurements. However, it is possible to make meaningful calculations of the terminal velocity of large meteors, including their impact velocity, because spherical particles up to about 50 cm in diameter will reach terminal velocity in the earth's lower atmosphere. Apparently, this is the first time this type of calculation was attempted for large meteors. Although the emphasis in this paper is on large meteors up to 50 cm in diameter, calculations of the terminal velocity are presented also for small meteors. These calculations substantiate Heide, who concluded that the atmosphere has an equalizing effect on the impact velocities of large meteors, whose increase in impact effect is mainly due to an increase in mass and not an increase in impact velocity. Author

N68-27890*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

SPECIAL DATA-REDUCTION PROCEDURES FOR PRAIRIE NETWORK METEOR PHOTOGRAPHS

R. E. McCrosky and A. Posen 10 May 1968 92 p refs
(Grant NsG-291-62)
(NASA-CR-95188; SAO-SR-273; Rept.-704-26) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The procedures employed to obtain trajectory and luminosity data from photographs of fireballs made with Prairie Network cameras are described. Complete trajectory and luminosity results are tabulated for 29 meteors. Author

N68-27892*# North American Aviation, Inc., El Segundo, Calif. Space and Information Systems Div.

STUDY OF A RENOVATED COMMAND MODULE LABORATORY AND RENOVATED COMMAND MODULE. VOLUME 4: RESOURCES REQUIREMENTS ANALYSIS Final Report

J. A. Moran and J. I. Dodds 15 Dec. 1966 199 p
(Contract NAS9-6445)
(NASA-CR-92158; SID-66-1853-4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A Renovated Command Module (RCM) concept is introduced and resources requirements and cost analyses were made of three types of vehicles from command module splashdown to delivery of the renovated vehicle. The vehicles included an RCM using a Block 2 recovered Apollo vehicle, a dependent RCM laboratory, and an independent RCM laboratory; and used Block 1 or Block 2 vehicles were considered for renovation as either dependent or independent laboratories. Ground operation requirements, test and operations, logistics analysis, and transportation and packaging were considered; as were manufacturing analysis, test requirements and program scheduling, cost analysis, materials analysis, and material support. M.W.R.

N68-27915*# Exotech, Inc., Washington, D. C. Systems Research Div.

PLANNING STUDY FOR AN ORGANIC CONSTITUENTS INVENTORY PROGRAM

Robert G. Lyle May 1968 41 p refs
(Contract NASw-1666)
(NASA-CR-94185; TRSR-68-029) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The feasibility of establishing and maintaining an inventory of the organic constituents of terrestrial origin delivered to the moon is evaluated. This recommended inventory is to provide for interpretation of analytical results from future collections of lunar material, as well as providing an estimate of costs associated with such an inventory system. Technical literature was surveyed to identify the programs which involve payloads destined for the moon, and information for each program was evaluated for usable data. Alternative models of inventory systems were structured and approaches for implementing them evolved so that comparative evaluations of the benefits, limitations, requirements, and costs could be made to identify practicable models and approaches. Practicable models were analyzed to enable comparisons of effectiveness, level of effort requirements to establish and maintain, estimated costs, and capability to accommodate changing requirements for future programs. It was concluded that if an inventory is to be undertaken, the least costly of the alternatives is for the retention and safeguarding of all existing documentation of analysis when the need arises. A.L.

N68-27962*# Auburn Univ., Ala. Engineering Experiment Station.

STUDY OF LIMIT CYCLES AND STABILITY OF A SPACE VEHICLE ATTITUDE CONTROL SYSTEM

W. W. Burge and D. W. Russell 24 Jul. 1967 15 p
(Contract NAS8-20104)
(NASA-CR-61847; TM-16) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Limit cycles, regions of stability, effects of parameter variations on stability, and methods to improve the stability of a three-axis space vehicle attitude control system were studied using both analytical and analog computer simulations. Attitude control was achieved by modulating the force (thrust) produced by the four engines or thrustors by using a value set by the throttle command signal. A second-order actuator positioned a valve for controlling the propellant flow and, therefore, the force produced by the engine. Since the actuator is velocity limited, the rate of change of force is limited. Using an ideal relay to represent the actuator, it was determined that the three-axis control system could possess at least three unstable limit cycles, that is, a limit cycle about each axis with conditions about the other two axes remaining quiescent. Conditions of stability about the origin were found to be the same as for a single-axis system, that is, all system gains must be positive. M.W.R.

N68-28028# Arkansas Univ., Fayetteville. Dept. of Chemistry.

RADIOACTIVE FALLOUT IN ASTRONOMICAL SETTINGS: PLUTONIUM-244 IN THE EARLY ENVIRONMENT OF THE SOLAR SYSTEM

P. K. Kuroda [1968] 28 p refs Presented at the 155th Natl. Meeting of the Am. Chem. Soc., San Francisco, 31 Mar.–5 Apr. 1968
(Contract AT(40-1)-2529)
(ORO-2529-17; CONF-680308-3) CFSTI: HC $3.00/MF $0.65

An attempt is made to find an analogy between the processes of formation and transport of "hot" single particles from nuclear weapons and formation of the solar system from the debris of supernova explosions. The detection of xenon isotopes in meteorites as a residue of ^{129}I and ^{244}Pu is considered. NSA

N68-28038*# Maryland Univ., College Park. Dept. of Physics and Astronomy.

THE COMETARY ORIGIN OF METEORITES

Ernst J. Oepik May 1968 34 p refs Presented at NASA, Goddard Space Flight Center, Greenbelt, Md., 27 Jun. 1968
(Grant NsG-58)
(NASA-CR-95845; TR-821) CFSTI: HC $3.00/MF $0.65 CSCL 03B

It is suggested that the meteorites have been produced in planetary collisions at a time when the giant planets (Jupiter) were formed. They were then imbedded in the ices of comet nuclei, which were subsequently ejected to Oort's sphere of comets. As the result of an interplay of stellar and planetary (Jupiter) perturbations, some nuclei are now returning to the inner solar system. After evaporation of the ices the enclosed meteorites are released. The total mass of debris from the periodic comets alone is amply sufficient not only to account for the meteorites, but also to contribute a considerable fraction of the much larger total mass of interplanetary dust. The absence of meteoritic objects from some meteor showers (Perseids) and their occurrence in others (Southern Taurids, from Encke's Comet) can be well explained by the circumstances of jet ejection of the particles competing with the gravitation of the nucleus. Author

N68-28092*# California Univ., Los Angeles. Space Science Center.

UCLA SPACE PROGRAM, DECEMBER 1967

Dec. 1967 92 p refs
(NASA-CR-95346; AD-668710) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This report includes summaries of space related research activities in the fields of physical sciences, biological sciences, and engineering. TAB

N68-28113*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MOTION OF AN ARTIFICIAL SATELLITE UNDER COMBINED INFLUENCE OF PLANAR AND KEPLERIAN FORCE FIELDS

Rowland E. Burns Washington Jul. 1968 57 p refs
(NASA-TN-D-4622) CFSTI: HC$3.00/MF$0.65 CSCL 22C

The development of the technology of artificial earth satellites has posed mathematical problems which heretofore were academic. One such problem is the radiation pressure perturbations of satellites with large area-to-mass ratios (i.e., Echo). The standard method of treatment of such a problem is a perturbational analysis of a purely Keplerian orbit which is disturbed by a radiation pressure field. It will be shown in this report that a generalized form of the two-body problem which more closely approximates the radiation pressure problem can be solved in closed form. Specifically, the problem of the motion of a satellite under the combined influence of Keplerian and planar force fields will be solved in terms of the elliptic functions. The assumption of a planar force field is still an approximation to the true radiation pressure problem because the divergence of the field is neglected. It is obvious that neglecting the divergence of the radiation pressure field is far less restrictive than disregarding the entire field. Perturbational treatment with the present solution as a model should converge far more readily than treatments which assume an initially Keplerian model. Author

N68-28184# California Univ., Livermore. Lawrence Radiation Lab.

ATTEMPT TO DETECT GAMMA RADIATION FROM THE CONSTELLATION CYGNUS

F. Charles Gilbert, Frederick D. Seward, and J. Peter Stoering 27 Feb. 1968 11 p refs
(Contract W-7405-ENG-48)
(UCRL-50384) CFSTI: HC$3.00/MF$0.65

In an attempt to observe X-rays and gamma rays between 100 keV and about 3 MeV from the Cygnus X-1 source, a balloon-borne experiment was conducted on April 22, 1967. The 511-keV positron–electron annihilation line was of particular interest. The detector assembly is described and operating characteristics are given. The upper limit found for Cyg X-1 was 0.07 photons/cm^2-sec. NSA

N68-28192*# Arizona Univ., Tucson.

CHRONOLOGICAL CATALOG OF REPORTED LUNAR EVENTS

Barbara M. Middlehurst, Jaylee M. Burley, Patrick Moore (Armagh Planetarium), and Barbara L. Welther (Smithsonian Astrophys. Obs.) Washington NASA Jul. 1968 55 p refs
(NASA-TR-R-277) CFSTI: HC$3.00/MF$0.65 CSCL 03A

A catalog of reports of lunar events, or temporary changes on the moon, was compiled based on literature covering more than four centuries. In most cases, the original reference was consulted; Houzeau and Lancaster's *Bibliographie Général d'Astronomie* and the *Astronomischer Jahresbericht* were useful secondary sources. Each entry includes a brief description and date of the observation; the name of the observer(s), where these are known; and the reference. Author

N68-28251*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON THE PERTURBATIONS OF SMALL-ECCENTRICITY SATELLITES

T. L. Felsentreger Washington Jul. 1968 49 p refs
(NASA-TN-D-4531) CFSTI: HC$3.00/MF$0.65 CSCL 22C

Difficulties have been encountered in the orbit determination of nearly circular earth satellites when "first-order" analytic perturbation theories have been used. "First-order" usually means that periodic terms are developed to order J_2 (the second zonal harmonic coefficient in the earth's gravitational potential), the secular terms to order J_2^2. If these theories are extended to include periodic terms of order J_2^2 and higher, the appearance of eccentricity as a divisor in the perturbations of eccentricity, mean anomaly, and argument of perigee causes many of these "higher-order" terms to be comparable in magnitude with the J_2 terms (for small-eccentricity satellites). Thus, the aforementioned difficulties can be attributed, at least in part, to the omission of these terms from the orbit-determination models. Von Zeipel's method is used to derive all such "small divisor" terms inclusive of J_2^3 and $(J_1/J_2)^3$, when J_1 is any odd zonal harmonic coefficient. Author

N68-28254*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

JPL RADAR RANGE AND DOPPLER OBSERVATIONS OF VENUS, 1961–1966

D. O. Muhleman, C. L. Lawson, D. B. Holdridge, and D. A. O'Handley 1 Jul. 1968 50 p refs
(Contract NAS7-100)
(NASA-CR-95374; JPL-TR-32-1123) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The JPL radar doppler observations of Venus taken during the inferior conjunctions of 1961, 1962, 1964, and 1966 and the radar range observations taken in 1964 and 1966 have been reduced from about 35,000 actual observations to 1179 compressed data points. This compressed data is presented along with a brief discussion of the observations. Author

N68-28275*# Boeing Co., Seattle, Wash.

LUNAR ORBITER 4. PHOTOGRAPHY

Washington NASA Jul. 1968 78 p
(Contract NAS1-3800)
(NASA-CR-1093; D2-100754-2, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Photographic mission design, actual photography, photographic supporting data, and operational performance for Lunar Orbiter 4 are detailed. Nearly complete coverage of the nearside and appreciable coverage of the farside of the moon were made at a resolution significantly better than earth-based observations. Nominal orbit parameters are included and general characteristics of mission photography along with meteoroid, energetic radiation, wind fogging, and light streaking effects are included. Perilune and apolune lunar landing sites are discussed and illustrated. Cameras, processor-dryer, and readout performances are summarized. M.W.R.

N68-28279# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Strahlantriebe.

CALCULATIONS OF OPTIMAL PAYLOAD TRANSPORT WITH ELECTRICAL PROPULSION TO A SYNCHRON ORBIT [BERECHNUNGEN UEBER DEN OPTIMALEN NUTZLAST-TRANSPORT MIT ELEKTRISCHEN ANTRIEBEN IN DIE SYNCHRONBAHN]

Wolf Rasch Dec. 1967 57 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-86) CFSTI: HC$3.00/MF$0.65

The payload is computed for orbit transfer from near earth parking orbit to synchronous orbit by electric propulsion. The nuclear electrical power supply is based upon incore thermionic reactor systems. The mass of the system depending on its electrical power, the efficiency of a mercury ion thruster on the exhaust velocity and the mercury propellant tank are taken into account. Regarding energy losses of 200 to 400 eV per ion and optimal exhaust velocities between 30 to 40 km/s transmission times of 50 to 90 days are possible depending on power level and initial mass in the parking orbit. Author

N68-28309*# Northrop Corp., Huntsville, Ala.

NUMERICAL SOLUTION OF FLOW FIELDS SURROUNDING SATURN TYPE VEHICLES

J. W. Hoole, T. J. Thomas, F. B. Tatom, and J. C. Williams, III Jun. 1968 110 p refs

(Contract NAS8-20409)

(NASA-CR-61856; TR-792-8-306; TR-382) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Numerical techniques and computer programs which can be used to predict the entire steady-state flow field around Saturn-type vehicles at zero angle of attack are discussed. Basic guidelines used were: (1) the bodies were restricted to bodies of revolution, (2) an ideal, inviscid gas with a supersonic free-stream velocity was used, (3) all shock waves in the flow field were treated as discrete discontinuities, and (4) separated flow phenomena were not considered. Because of the geometry of the bodies and the flow conditions, both subsonic and supersonic flow regions were considered. Each such region was treated separately after which the resulting flow fields were coupled together. A time dependent finite difference technique was used to compute the subsonic flow region behind detached bow shocks of blunt- and sharp-nose bodies. In a similar manner, the flow field about an expanding frustum with a slope too large to support supersonic flow was computed by a time dependent finite difference technique. A Taylor–Maccoll numerical integration technique was used to compute the flow around a sharp nose body when the shock wave was attached. The supersonic flow regions around the cylindrical sections of the body were computed with a two-dimensional method of characteristics. The techniques used in this research effort should prove to be valuable tools for predicting the complete inviscid, steady state flow field around Saturn-type vehicles. The techniques developed for the calculations of the subsonic field around a frustum is the only known means available for this type of calculation; however, due to the lack of available data for comparison, the results for the frustum have not been validated. Author

N68-28328 Iowa State Univ. of Science and Technology, Ames.

THE ATMOSPHERE OF VENUS: A DUST INSULATION MODEL

James Edward Hansen (Ph.D. Thesis) 1967 287 p

Available from Univ. Microfilms: HC $13.05/MF $3.70 Order No. 67-9062

Despite the fact that Venus is our nearest planetary neighbor, the conditions in the lower atmosphere and on the surface of that body are still very uncertain, primarily due to the continuous cloud cover which shrouds the planet. Several years ago strong radio frequency emission from the planet was discovered. The atmospheric models which attribute the high radio frequency temperature to the planetary surface appear to be promising but they have a common difficulty in trying to explain how the atmosphere can simultaneously transmit solar energy to warm the surface and blanket the planetary thermal emission. For the above reason we are led to propose that the source of energy heating the surface is not the sun, but is rather located beneath the atmosphere. We assume only that the amount of energy escaping from the planet's interior is on the same order as that escaping from the earth and for reasons presented in Chapter IV we are led to believe that the atmospheric blanketing of the surface energy is caused by a dusty atmosphere. Dissert. Abstr.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N68-26979*# North American Aviation, Inc., Downey, Calif.* Space and Information Systems Div.

STUDY OF A RENOVATED COMMAND MODULE LABORATORY AND RENOVATED COMMAND MODULE. VOLUME 3: SUBSYSTEMS ANALYSIS Final Report

J. A. Moran and J. I. Dodds 15 Dec. 1966 478 p refs

(Contract NAS9-6445)

(NASA-CR-92157; SID-66-1853-3, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Reported are results of the subsystem analysis conducted primarily to ascertain the technical feasibility of the renovated Apollo command module concept. Two general renovated command module (RCM) applications considered in the study were: (1) an RCM spacecraft (using only Block II subsystems) for use in an AAP operational CM in a fourteen-day, low altitude, low inclination earth orbit; and (2) RCM laboratories (using Block I and II subsystems) based on four previously described reference missions. Assessed were the following: structures and materials; heat shielding; environmental control and life support systems; electric power systems; communications and data equipment; displays and control; instrumentation; landing, recovery, and docking systems; guidance and navigation equipment; stabilization and control equipment; the entry monitor subsystem; and the reaction control system. On the basis of these studies it was determined that renovation for the RCM spacecraft requires approximately 25% of the spacecraft components to be replaced and 47% refurbished, while 28% can be tested and reused. A preliminary study of the feasibility of refurbishment of the Apollo command module heat shield is also described. S.C.W.

N68-27189# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

A TIME-LAG GENERATOR FOR SPACECRAFT MAGNETIC DAMPING SYSTEMS

Roy F. Sloan Jan. 1968 69 p refs

(Contract NOw-62-0604-c)

(TG-965; AD-668138)

The circuit design of a subsystem used to approximate a time lag of several hours for use in spacecraft magnetic damping systems is discussed. Prior to the discussion of the electronics, a brief and very basic description is given of how the damping system operates and how the time-lag generator contributes to its operation. Two circuit designs are then discussed in detail. The first employs a simple sample-and-hold technique and was used in the DODGE satellite. The second, an extension of the first, uses an additional level of memory and might find application in similar satellites in the future. Some results of breadboard tests of both types of time-lag generator are included. Author (TAB)

N68-27204*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

MARINER VENUS 67 SPACECRAFT ENVIRONMENTAL TEST RESULTS

George C. Ragsdale and Donald C. Meenard 15 Jun. 1968 262 p refs

(Contract NAS7-100)

(NASA-CR-95149; JPL-TR-32-1249) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This report details the *Mariner* Venus 67 environmental program, which included type approval testing, developmental and special investigative testing, and flight acceptance (FA) testing at both the subsystem and system levels. First, the overall test program is described and summarized; then the development and qualification of the spacecraft are discussed; and finally, the FA testing of each spacecraft and its subsystem is described. Within each section, the tests are described in detail and results are given. Problems encountered during testing and anomalies resulting from the tests are discussed, and summaries of all waivers and test deviations are included. A section is included that discusses the magnetic control test program, and the appendixes contain information on special tests and subjects related to the spacecraft environmental test program. The depth of coverage of the report allows an evaluation of the philosophy forming a basis for the test program. Recommendations for future programs result from these evaluations and are included in the final section of the report. Author

N68-27384# National Research Council of Canada, Ottawa (Ontario). Space Research Facilities Branch.

BLACK BRANT ROCKETS AAF-2-108 LAUNCHED AT CHURCHILL RESEARCH RANGE, JANUARY 1968

Apr. 1968 34 p refs

(SRFB-010) CFSTI: HC$3.00/MF$0.65

This report deals with the engineering aspects of preparing the payload and the launching of Black Brant rocket AAF-II-108 at Churchill Research Range on 18 January, 1968. The primary experiment was the measurement of electron density and temperature in the auroral zone under quiet geophysical conditions at night. Plasma probe instrumentation included all previously flown types in order to provide an undisturbed baseline to which all previous measurements could be related. Other measurements included auroral airglow, micrometeoroid detection, neutron intensity, ionospheric inhomogeneity and absorption, electric field probes and the recording of the spectrum and flux of incoming electrons in the upper atmosphere. Author

N68-27470*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

APPLICATIONS OF COMPOSITE MATERIALS IN SPACE VEHICLE STRUCTURES

Richard R. Heldenfels [1967] 36 p refs Presented at the Intern. Conf. on Mech. of Composite Mater., Philadelphia, 8–10 May 1967

(NASA-TM-X-60069) CFSTI: HC$3.00/MF$0.65 CSCL 22B

The characteristics of filamentary composite materials are reviewed and evaluated for use in structural design of space vehicles. Several potential applications are discussed, among them: (1) propellant tanks, interstage structures, payload shrouds, and rocket nozzles for solid, liquid, and reusable launch vehicles; (2) pressure vessels, antennas, power arrays, meteoroid shields, and trusses for manned spacecraft and stations; (3) thermal protection, aeroshells, and deployable decelerators for Earth and planetary entry vehicles; and (4) energy absorbers, frameworks, and cabin walls for landing modules and shelters. K.W.

N68-27530*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

COST OPTIMIZATION OF MULTISTAGE ROCKETS

Paul R. Hill [1967] 14 p refs Presented at the Conf. on the Use of Space Systems for Planetary Geol. and Geophys., Boston, 25–27 May 1967

(NASA-TM-X-60089) CFSTI: HC$3.00/MF$0.65 CSCL 22D

The optimization of large rocket systems for minimum cost rather than minimum system weight may possibly save millions of dollars per flight. A simple method of optimizing tandem-staged rocket systems for either minimum weight or minimum cost is reviewed. The easily used recursion equations presented apply equally well to either objective. The method applies to any number of stages and takes into account the parameters of stage jet velocity, stage inert mass fraction, and stage specific cost or dollars per pound. It is shown that when the unit cost of the several tandem stages are equal a minimum weight solution is a minimum cost solution. When the unit cost varies markedly from stage to stage it is important to select the relative stage weights to minimize the cost. An example of a rocket system to carry a 20,000 lb payload to escape speed utilizing a solid fuel first stage with hydrogen fueled second and third stages showed the minimum cost system weighs 21 percent more but costs 25 percent less than the corresponding minimum weight system. No mathematical optimization method can be expected to accurately predict final system weights and costs, but can be very worthwhile in quickly orienting the detailed and laborious hardware design studies which must eventually be made. Author

N68-27641*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

BIOSATELLITE PROJECT

Pierre M. Hahn [1967] 19 p Presented at the British Interplanetary Soc., Intern. Summer School, "Biology in Space," Cambridge, England, Jul. 1967

(NASA-TM-X-60424) CFSTI: HC$3.00/MF$0.65 CSCL 22B

The overall mission planning, spacecraft configurations, and primary scientific objectives are outlined for the series of six earth-orbiting flights approved for the Biosatellite project. For each flight a spacecraft with a recoverable experiment capsule is to be placed into a nominally circular orbit by a two-stage thrust-augmented improved Delta launch vehicle; orbital flight time will vary from 3 to 30 days, depending on the experiment. Summary information on the subsystems is included. The major experiments for the 3-day mission cover general biology, plant physiology, and radiation biology. For the 30-day mission of subhuman primates, the experiments are directed at an understanding of neurophysiology and behavior, cardiovascular physiology, calcium turnover, and urinalysis of metabolic constituents. The 21-day mission plan includes general biology and planet physiology experiments. M.G.J.

N68-27722*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

PLANETARY VEHICLE THERMAL INSULATION SYSTEMS Final Report

S. J. Babjak, R. W. Carr, A. D. Cohen, C. S. Lankton, R. Ludwig et al 3 Jun. 1968 174 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951537)

(NASA-CR-95253; DIN-68SD4286) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Thermal analyses, materials evaluation testing, fixture and blanket design, and environmental tests were made for planetary vehicle thermal insulation systems. Thermal insulation blanket materials compatible with dry heat sterilization, ethylene oxide (ETO) decontamination, and the combined space environment were made on aluminized Kapton, Mylar, and Teflon; dimpled aluminized Mylar; goldized Kapton and Mylar; and dacron mesh. Insulation tapes evaluated are aluminized Mylar with adhesive, Kapton with adhesive, and hook and pile. Full scale thermal vacuum tests were conducted; and data are given on temperature, capsule insulation performance, and heat flow and balance. Gold on Mylar or Kapton insulation systems, which provided adequate thermal protection throughout all mission phases, are compatible with currently recommended decontamination and sterilization environments. Excessive ballooning during launch depressurization was prevented by vent holes in the insulation blankets. Aluminum plastic films were found to be unreliable in ETO environments. Tinger fasteners in conjunction with pressure sensitive hook and pile were satisfactory, and clear Kapton was used for completing insulation joints. Kapton-based insulations are most suitable for outer layers. M.W.R.

N68-27796*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

YO-YO DESPIN MECHANISMS

Kenneth S. Bush [1967] 20 p refs Presented at the 2d Aerospace Mech. Symp., San Francisco, 4–5 May 1967
(NASA-TM-X-60068) CFSTI: HC$3.00/MF$0.65 CSCL 22B

The fundamental principles and performances of three yo-yo type despin systems are presented. Design parameters and criteria, systems description and results of specific applications are given for a single stage yo-yo despin system, a two stage yo-yo despin system, and a stretch yo-yo despin system. B.S.D.

N68-27797*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

MANNED LIFTING BODY FLIGHT TESTING

Milton O. Thompson, Bruce A. Peterson, and Jerry R. Gentry [1966] 39 p Presented at the SETP 10th Symp., Los Angeles, 23 Sep. 1966
(NASA-TM-X-59042) CFSTI: HC$3.00/MF$0.65 CSCL 22B

A lifting body flight test program is described in which the objectives are (1) to test a cross section of proposed lifting body shapes; (2) to assess and evaluate the stability, control, handling qualities and maneuverability of these configurations in the transonic and low supersonic speed regimes; and (3) to determine the capability of pilot to control maneuver, flare and land a lifting body. The three research vehicles, M-2/F-2, HL-10, and SV-5P, are described, and the various parameters exemined on the flight of the M-2/F-2 are discussed. B.S.D.

N68-27802*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE LUNAR ORBITER PHOTOGRAPHIC SYSTEM

G. Calvin Broome and Joseph C. Moorman [1967] 34 p refs Presented at the Soc. at Phot. Sci. and Engr. Ann. Conf., Chicago, 15–19 May 1967
(NASA-TM-X-60095) CFSTI: HC$3.00/MF$0.65 CSCL 22B

With the highly successful flights of Lunar Orbiter spacecraft, NASA is well along toward accomplishment of the Lunar Orbiter program objectives. These objectives include the primary goal of photography of the lunar surface to aid in the selection of safe landing sites for Project Apollo, as well as secondary goals of obtaining information of general scientific interest on the origin and history of the moon and its gravitational parameters. The Lunar Orbiter system is described, with emphasis on the design and inflight performance of the photographic system. Consideration is given to both the problems and advantages of film-type photographic systems for deep space applications. Selected photographic and performance data from Lunar Orbiter missions are presented. Author

N68-27920# Goodyear Aerospace Corp., Akron, Ohio.

ADVANCED ORBITING GRID SPHERE PASCOMSAT

Frederick J. Stimler *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 41–59 refs (See N68-27917 16-32)

A program designed to determine the feasibility of using orbiting wire grid experimental satellites as global radio links is reported. Materials development, fabrication and assembly techniques, hardware considerations, component and subassembly performance test data, and flight test results for a 30 foot diameter wire grid experimental satellite (PasComSat) are reported. The satellite was prepared for launch to verify deployment, film photolyzation, rf effectiveness, and payload design parameters. Analysis of flight data verified that the sphere structure and related equipment operated as designed and that the rigidized wire grid PasComSat will remain in a stable orbit indefinitely. Preliminary data analysis verified the reduced solar pressure and drag effects on the open grid sphere. Environmental test results of the sphere material (polybutyl methacrylate); payload components (OV1-7, a GD/C experimental payload, and the OV1-8(P), the grid sphere payload); and subsystems showed the design concept to be simple and reliable. It is suggested that similar expandable structure applications, such as other types of passive communications satellites, wire film tube structures, exo-atmospheric decoys, and radar calibration targets, can be solved with an adaptation of the proposed design technique. Recommendations for design approaches to be used prior to the development of an operational PasComSat system are included. S.C.W.

N68-27927# Air Force Systems Command, Wright-Patterson AFB, Ohio.

PAGEOS FABRICATION ACCURACY AND RELIABILITY

S. J. Stenlund *In its* Expandable and Modular Struct. Conf. May 1967 p 181–193 (See N68-27917 16-32)

The Pageos program was the first time that a space satellite reliability program has been used in the design and fabrication of a very large inflatable satellite. This paper covers the design and performance of the 100-foot diameter Pageos Satellite and the program used in predicting its reliability. The mathematical technique for reliability prediction was developed. The technique utilizes known theory of probability in evaluating representative random samples of conponent characteristics. The end result is component, operational phase, and ultimately system reliability prediction including estimation of failure rates. This model was successfully applied to the recently launched Pageos inflatable satellite. Other typical applications are to structures such as passive communications satellites, high altitude balloons, expandable space shelters, expulsion bladders, erectable penetration aids and space microwave structures. Author

N68-27934# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

THE REQUIREMENTS AND ROLE OF EVA ASSOCIATED WITH ORBITAL STRUCTURES

R. G. Clodfelter and R. A. Stewart (Textron's Bell Aerosystems Co.) *In its* Expandable and Modular Struct. Conf. May 1967 p 345–363 refs Presented at the 3d Aerospace Expandable and Modular Struct. Conf., May 1967 (See N68-27917 16-32)

Requirements and the role of an EVA (extravehicular astronaut) in the deployment, assembly and maintenance of in-space erectable structures during earth orbital missions are discussed. The relative effectiveness of EVA is delineated, and equipment requirements for providing EVA orbital support to the erection of large structures are defined. The potential EVA role associated with each of the following assembly techniques are identified: modular, erectable, expandable, formed in place, chemical rigidizing, and combination. A number of fundamental EVA tasks were synthesized from a review of the assembly techniques and joining operations associated with these techniques, i.e., welding, brazing, metal fastening, adhesive, and pyrotechnic, as well as the specific mission requirements. These fundamental EVA tasks reduce themselves to the following: module positioning, alignment, and attachment; erection monitoring; adjustment of elements; thermal joining; mechanical fastening; modification; and maintenance. Pertinent characteristics regarding astronaut capabilities and limitations in a full pressure suit which are primarily guidelines in defining the ability to perform extravehicular tasks; and more pertinent equipment items which have been identified for EVA across the spectrum of orbital structure utilization; are summarized. Equipment classifications include primary equipment such as personnel life support packs and space suits; EVA secondary support equipment common to all missions such as handrails for surface locomotion, and finally mission support equipment which could be required to support a particular mission. S.C.W.

N68-27936# Texas Univ., Austin. Coll. of Business Administration.

SPACE FLIGHT SAFETY

Eugene B. Konecci and Alice G. K. Kleberg *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 391–399 (See N68-27917 16-32)

Safety aspects of manned space flight are discussed. Emphasized is the impact of the Apollo I spacecraft accident on (1) the respective management roles of the government-industry aerospace teams; (2) research and development program safety considerations; (3) escape technologies; and (4) future national aeronautics and space programs. It is surmised that research and development efforts focusing on the development of expandable and modular structures are providing the technologies needed to give an interim space escape/rescue capability. Described are programs under development which have incorporated new and different development concepts of survival and escape systems such as the proposed Expandable Airlock Experiment for the SIVB Workshop; the D-22 Experiment technology of a space rigidized metal truss recovery capsule with heat shield; and MOOSE (Manned Orbital Operations Safety Equipment) research and development technology. In view of the fact that the space program is a pioneering research and development effort, it is concluded that the first constraint that must be accepted is that regardless of the technical effort projected and the money spent, 100 percent success of all manned space missions cannot be guaranteed. It is further surmised, however, that a good flight safety program, well managed, will minimize the risks and insure acceptable safety standards and training without impeding progress in the space program. S.C.W.

N68-27941# Air Force Systems Command, Wright-Patterson AFB, Ohio.

VARIABLE GEOMETRY LIFTING SURFACES FOR LIFT RE-ENTRY

Jerry D. O'Brian *In its* Expandable and Modular Struct. Conf. May 1967 p 485–513 refs (See N68-27917 16-32)

Preliminary design feasibility studies of variable geometry structural concepts for lifting reentry vehicles are reported. Focused on were problems involved in a reentry environment, and penalties incurred with the addition of deployable lifting surfaces. Combinations of three basic reentry vehicles, three wing planforms, and three construction methods were studied to determine the feasibility of the variable geometry concept as a function of lifting surface location and construction. A representative variable geometry concept for each of the three vehicles was chosen for a more detailed structural and weight analysis. The basic requirement to be met by each configuration was that the wing planform area be sufficient to provide a minimum L/D max of 4.5 during the landing phase of terminal reentry. The vehicles to which the variable geometry concept was applied were the modified elliptically shaped SORTIE, the slender conical shaped M-22F, and a medium L/D reentry configuration. An assessment of results of studies on each of these vehicles is given. Results indicate that: (1) construction of a rigid type wing appears feasible with present state of the art materials and fabrication methods and offers the advantages of high speed deployment and reusability; and (2) disadvantages are the weight and volume penalties which are related to the wing position of the vehicle. S.C.W.

N68-28144# Los Alamos Scientific Lab., N. Mex.

HEAT PIPE PERFORMANCE IN A SPACE ENVIRONMENT

J. E. Deverall and E. W. Salmi [1967] 4 p refs Presented at the IEEE Thermionic Conversion Specialist Conf., Palo Alto, Calif., 30 Oct.–1 Nov. 1967
(Contract W-7405-ENG-36)
(LA-DC-9028; CONF-671045-3) CFSTI: HC $3.00/MF $0.65

The unusual thermal characteristics of the heat pipe indicate that it has great potential for the solution of heat transfer problems in satellites. In order to demonstrate that heat pipes will function normally under space conditions, a water heat pipe was launched into an earth orbit by an Atlas–Agena vehicle to determine the effect of a zero-gravity field on its operation. A second experiment was conducted in which a similar heat pipe was subjected to typical sinusoidal and random vibrations experienced by a satellite during the missile launch period. The results of the experiments indicate that heat pipes are suitable for space applications. Author (NSA)

N68-28198*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE EXPLORER 23 MICROMETEOROID SATELLITE. DESCRIPTION AND RESULTS FOR THE PERIOD NOVEMBER 6, 1964, THROUGH NOVEMBER 5, 1965

Robert L. O'Neal, comp. Washington Jun. 1968 111 p refs
(NASA-TN-D-4284) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The Explorer XXIII was placed in orbit on November 6, 1964, with a perigee of 464 km and an apogee of 980 km. It carried stainless-steel pressurized penetration detectors, impact detectors, and cadmium sulfide cells to provide data on the near-earth meteoroid environment. In addition, the spacecraft was designed to provide data on the effects of the space environment on the operation of capacitor type of penetration detectors and solar-cell power supplies. The spacecraft operated satisfactorily during the 1-year design life, and the objectives of the mission were accomplished. The puncture rates obtained for stainless steel on Explorer XXIII are close to the puncture rates obtained for beryllium copper on Explorer XVI. The confidence limits include the data points obtained from Explorer XVI. A total of two counts were recorded by the capacitor-detector experiment during the 1-year reporting period. No conclusions can be reached concerning the effects of the space environment on the detector operation. The capacitor-detector monitoring circuit indicated that both detectors maintained bias voltage during the 1-year period. The counting rates on the high- and medium-sensitivity meteoroid-impact-detection systems when converted to equivalent puncture rates gave much higher averages than did the pressurized-cell puncture rates. The data from these two systems appear questionable. A meteoroid penetration model was developed, and defined for stainless steel. Author

N68-28202*# Boeing Co., Seattle, Wash.

LUNAR ORBITER 5: PHOTOGRAPHY Final Report

Washington NASA Jun. 1968 229 p
(Contract NAS1-3800)
(NASA-CR-1094; D2-100755-2, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This Lunar Orbiter final report contains a description of Mission V planning, its conduct with respect to photography, and an evaluation of the photographic results. Data pertinent to analysis and interpretation of the photographs by the user are included. Near-vertical, convergent telephoto stereo-scopic, and oblique photography was used to obtain the desired data. Either single- or multiple-frame sequences were taken for coverage appropriate for the particular site. All photography planned for the mission was accomplished and the photographs were reconstructed. Author

N68-28219*# General Dynamics/Convair, Huntsville, Ala.

APPLICATIONS OF DISCRETE NETWORK SIMULATION IN SPACE VEHICLE CHECKOUT. VOLUME 2: COMPUTER PROGRAMS Final Report

Dec. 1967 257 p refs
(Contract NAS8-21102)
(NASA-CR-61855; GDC-DDF67-004, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The family of Discrete Network Simulation Programs were initially developed as a tool for time oriented simulation and analysis of man machine systems. With this technique the operation of complex systems can be accurately simulated. During the development of DNS, repeated testing has proven its value as an aid to technical data generation, projected failure analysis, and automatic malfunction analysis. It has been shown to be a versatile tool thats application is limited only by the imagination of the user. Under the present contract the application of DNS as an instrument to aid in the validation of Saturn V system test procedures was initiated. In order to optimize the technique of that procedure validation, and effect on overall improvement in the versatility of DNS, certain programming tasks were undertaken during this contract period. Changes were incorporated to existing DNS programs and several new programs were written to accomplish the task of test procedure validation. The new programs are covered in detail in this volume. Author

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N68-26972*# Pennsylvania State Univ., University Park.
EXPERIMENTAL INVESTIGATION ON FRACTURE OF VISCOELASTIC MATERIALS UNDER BIAXIAL STRESS FIELDS
M. G. Sharma and C. K. Lim [1967] 35 p refs Presented at the Spring Meeting of the Soc. for Experimental Stress Analysis, Ottawa, 16–19 May 1967 Prepared for JPL
(Contracts NAS7-100; JPL-950875)
(NASA-CR-88595; SESA Paper-1221) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The fracture behavior of two viscoelastic materials is examined for several biaxial stress fields corresponding to tension–tension quadrant of principal stress plane. Two copoloymers of butadiene and acrylic acid were selected for study of uniaxial and biaxial fracture, creep behavior, and uniaxial tension stress–strain characteristics. A biaxial stress apparatus is described for simultaneously studying the effect of rate of loading on fracture behavior of low modulus viscoelastic materials. Using the fracture data for various biaxial stress fields, true octahedral shear stress and strain values were calculated for both materials. Expressions are derived for obtaining three dimensional stress-strain relation for a linear viscoelastic material in creep, and total fracture energy at various biaxial stress fields and stress rates. It is concluded that the total strain energy at fracture for the composite material calculated from the linear viscoelastic theory agrees with experimental results, and that there exists a linear relationship between octahedral shear stress and hyperbolic sine value of octahedral shear strain. B.S.D.

N68-26990# North Carolina State Coll., Raleigh. Applied Mathematics Research Group.
THE STRESS INTENSITY FACTORS FOR A GRIFFITH CRACK WHOSE SURFACES ARE LOADED ASYMMETRICALLY
I. N. Sneddon and B. C. O. Ejike 24 Apr. 1968 23 p refs
(Grant AF-AFOSR-444-66)
(AFOSR-68-0853; AD-668462)

Formulae for the calculation of the stress intensity factors at the tip of a Griffith crack and for the normal component of the surface displacement are derived for a crack whose surfaces are subjected to completely arbitrary surface tractions. Author (TAB)

N68-26991 Brown Univ., Providence, R. I.
ON THE FINITE DEFORMATION OF A CLASS OF SCREW AND ROTATIONAL DISLOCATIONS
Edmund Berkeley Ranby (Ph.D. Thesis) 1966 59 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2281

A class of deformations is examined using the full nonlinear theory of elasticity, to determine the conditions under which rotational and screw dislocations are possible in the absence of body forces. For the compressible material a nonlinear ordinary differential equation of the second order results; for the incompressible case, the stresses can be fully determined in terms of the constitutive functions. Restrictions are obtained on the constitutive functions for an incompressible material, in order that radially dependent axial and angular shears can accompany the dislocations but still give compatible equations of equilibrium. The general solution to the problem is then obtained for the compressible material, within the framework of the second order theory elasticity. The dilatation and volume change are calculated, and the effects of allowing torsion noted. Dissert. Abstr.

N68-27040# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
FUNCTIONALIZATION OF PYROCERAM 9606 TEST DATA FOR RADOME THERMAL-STRESS ANALYSIS
Manford B. Tate Mar. 1968 22 p refs
(Contract NOw-62-0604-c)
(APL-TG-980; AD-668136)

For the thermal-stress analysis of radomes built of Pyroceram 9606, the experimentally determined material properties and thermal expansion are studied and expressed as functions of the temperature. The data reduction methods are described in the text and appendix. They were generally based on minimization of the squared error function. In a few cases, the method of equalizing the maximum positive and negative percentage errors was employed. Different regression formulas for different uses are given, according to the degree of accuracy that the analyst elects to maintain. Overall, the derived functions represent the test points within 0.3 to 3 percent approximately, depending on which expression is selected for a particular application. Author (TAB)

N68-27047# Technische Hochschule Munchen (West Germany). Institut fuer Technische Mechanik.
STRESS CONCENTRATION WITH FATIGUE LOADING Final Report, 1 Jan.–31 Dec. 1966
Heinz Neuber and Ludwig Bertele Wright-Patterson AFB, Ohio AF Materials Lab. Mar. 1968 52 p refs
(Contract AF 61(052)-671)
(AFML-TR-68-19; AD-668774)

The influence of stress concentration on the fatigue behavior of mild cold drawn steel ST 42 K was investigated. Axial fatigue tests were performed at room temperature with a frequency of about 10 and 2000 cpm with cylindrical smooth and circumferentially notched specimens (notch root radius = 1.0 mm and 3.5 mm) in the endurance range N = 1/4 to 10 to the 7th power load cycles. The mean stress was varied between compression and the nominal tensile strength. The Hookian stress concentration factor was calculated to 1.7 and 2.7. The experimentally determined fatigue strength reduction factor (ratio plain fatigue strength to notched fatigue strength at sigma sub M = 0 and N = 10 to the 7th power) was 1.5 and 2.5. By application of Neuber's notch stress theory an approximative precalculation method for the fatigue strength reduction factor is established. Author (TAB)

N68-27055# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.

ANALYSIS OF THE FLEXURE TEST OF BIDIRECTIONAL COMPOSITES Technical Report, Jul.–Sep. 1967

N. J. Pagano and S. W. Tsai Mar. 1968 17 p refs
(AFML-TR-67-366; AD-669056)

Equations are presented which permit a more realistic evaluation of flexure experiments on bidirectional composite beams. The influence of shear deflection is discussed, and predicted results are compared to experimental data. Author (TAB)

N68-27211# Texas Univ., Austin. Dept. of Aerospace Engineering.

EXPERIMENTAL OBSERVATIONS ON THE NONLINEAR FLEXURAL VIBRATIONS OF THIN-WALLED CIRCULAR CYLINDERS

Emil E. Cwach and Ronald O. Stearman Jan. 1968 44 p refs
(Grant AF-AFOSR-1234-67)
(AFOSR-68-0516; AD-668650)

Nonlinear flexural vibration experiments were performed on a 0.0033 inch thick, 16 inch diameter, and 16 inch long seamless copper circular cylinder. The study was designed to investigate the possible existence of certain nonlinear forced response vibration phenomena that have been theoretically predicted in the literature but not demonstrated experimentally. Sufficient experimental data was also taken to allow quantitative comparisons with the existing theoretical studies. Many of the nonlinear vibration phenomena predicted theoretically were observed in the present experiments. These include the well known nonlinear jump or hysteresis in the amplitude frequency response curves, and the coupled mode instability. Ultraharmonic responses were also observed. For a prescribed forcing function amplitude, however, the ultraharmonic amplitudes of response at a given mode shape and frequency were small compared to the harmonic responses for that modal configuration and frequency. Finally large vibration amplitudes were observed in subharmonic modes of shell response. Although subharmonic modes of shell response were not considered in detail in any of the existing theories they represented a very significant vibration mode in the present experimental studies. The experimental data in the present study correlates quite well with one of the more current theoretical studies. Some effects of shell imperfections were noticed but no quantitative data were obtained. Author (TAB)

N68-27214# IIT Research Inst., Chicago, Ill.

A UNIQUENESS THEOREM IN THE LINEAR THEORY OF ELASTICITY WITH MICROSTRUCTURE

Warren S. Edelstein Apr. 1968 11 p refs
(Contract N00014-67-A-0210-001)
(TR-3; AD-668624)

It is shown that in the Mindlin theory of elastic materials with microstructure, uniqueness holds for the traction, the displacement, and a wide variety of mixed problems, provided the potential energy function W is homogeneous of order two. Author (TAB)

N68-27263# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE SEARS THEORY OF LONGITUDINAL COLLISION OF RODS [K TEORII SIRSA PRODOL'NOGO SOUDARENIYA STERZHNEY]

S. A. Zeghzda *In its* Herald of Leningrad Univ. Math. Mech., and Astronomy Ser. 23 Jun. 1967 p 98–109 refs (See N68-27244 16-19)

An approximate method is proposed for the integration of the Sears equation. The article deals with the problem of the longitudinal central impact of two homogeneous cylindrical bars. It is assumed that at the initial moment the centers of gravity of the cross sections lie on one straight line containing the point of contact, and that the surfaces of the rod ends in the area surrounding the point of contact can be approximated by second-order surfaces. The other two ends of the rods are assumed to be plain and normal to their longitudinal axes. Two cases are considered: (1) both rods are free; (2) one rod is free, and the other rigidly fixed. The system of equations derived by Sears is reduced to one dimensionless equation, which is then replaced by a simpler approximate equation. Author

N68-27264# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

REMARK ON REGULARIZATION OF A SINGULAR SYSTEM OF THE ISOTROPIC THEORY OF ELASTICITY [ZAMECHANIYE O REGULYARIZATSII SINGULYARNOY SISTEMY IZOTROPNOY TEORII UPRUGOSTI]

V. G. Maz'ya and V. D. Sapozhnikova *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 206–309 refs (See N68-27244 16-19)

The expressions for regularizators of conjugate singular integral systems corresponding to the first and second boundary value problems of the isotropic theory of elasticity are found. Author

N68-27351*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

RESIDUAL STRENGTH IN THE PRESENCE OF FATIGUE CRACKS, PART 1

Paul Kuhn Washington 17 Apr. 1967 75 p refs Presented at the Struct. and Mater. Panel of AGARD, Turin, 17 Apr. 1967
(NASA-TM-X-59836) CFSTI: HC$3.00/MF$0.65 CSCL 20K

A survey of engineering practices was conducted in aeronautical organizations and firms in order to assess the current state of knowledge concerning the residual strength of: (1) material specimens containing fatigue crack failure initiation of known proportions; and (2) typical structures using various types of materials. Critically examined are calculation methods useful to the structural design engineer for determining the strength of simple sheet specimens. Included are methods for notch and crack strength analyses as well as the methods of Critchlow, Christensen–Denke, Welbourne, McEvily–Illg–Hardrath, Griffith–Irwin, Broek, the comparison plots, and the log–log plot. The application of these methods to such materials as high-strength steels, titanium alloys, ceramics, and aluminum alloys is considered. K.W.

N68-27397*# Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Research and Engineering Center.

EXPERIMENTAL INVESTIGATION OF THE DYNAMIC RESPONSES OF A LAUNCH VEHICLE MODEL Final Report

C. S. Chang Feb. 1968 232 p refs
(Contract NAS8-20374)
(NASA-CR-61575; LMSC/HREC-A791239; HREC-0374-1) CFSTI: HC$3.00/MF$0.65 CSCL 22D

An experimental program was conducted to investigate the elastic and damping properties of a 1/5 scale structural model of launch vehicle Saturn SA-1. Dynamic responses of the model under sinusoidal and random excitations were studied. Author

N68-27409*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

RESIDUAL STRENGTH IN THE PRESENCE OF FATIGUE CRACKS (PART 2)

Paul Kuhn Washington 1967 38 p refs Presented at the Struct. and Mater. Panel—AGARD, Ottawa, 25 Sep. 1967
(NASA-TM-X-60503) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The effects of sheet and plate thickness on cracks extending through the metal are reviewed. Fracture mechanics and the validity of test measurements are briefly discussed, and it is felt that the problem of obtaining valid data exists for aluminum and titanium alloys and steels. It is considered that thickness may be a more important factor for notch strength than metallurgical differences. The problems associated with surface cracks and the analysis of a complex structure containing cracks are also mentioned.
N.E.N.

N68-27426# National Engineering Lab., Glasgow (Scotland).

EFFECT OF PIN BENDING ON THE STRESS DISTRIBUTION IN THICK PLATES LOADED THROUGH PINS

R. M. G. Meek Aug. 1967 19 p refs
(NEL-311)

A photoelastic investigation of the distribution of the peak stresses occurring in the plate at the edge of the hole in four pin joints having different ratios of plate thickness to pin diameter is reported. For a plate of square cross-section the peak stress was found to be more than twice that which would occur if the pin did not bend. Further measurements of stress distribution obtained from other models showed that radiating the corners of the hole resulted in an increase of the peak stress but that the peak stress was reduced when the modulus of elasticity of the pin material was three times that of the plate. Results from a bar having a pin inserted diametrically showed that for the same peak stresses weight may be reduced by the use of members of circular cross-section rather than of rectangular or square section. Author

N68-27431# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.

LUMPED PARAMETER BEAM MODELS BASED ON MECHANICAL IMPEDANCE Interim Report, Mar. 1967–Feb. 1968

Vernon H. Neubert and H. T. Hahn Feb. 1968 86 p refs
(Contract Nonr-656(28) (X))
(IR-7; AD-668701)

Using an impedance approach, an optimum three mass model is developed to represent a segment of a uniform Bernoulli-Euler beam. The four by four impedance matrix relating shear force, bending moment, slope, and deflection at the two ends of the element is given for the uniform beam and for the lumped parameter model. Position and size of the masses are chosen so that the impedance matrix for the optimum lumped parameter model will be the same as that for the uniform beam in the low frequency range. It is demonstrated that transient shear and bending stresses due to ground shock are represented accurately with fewer degrees of freedom using the optimum model developed. Evaluation of combinations of models is included. Author (TAB)

N68-27450# McDonnell Aircraft Corp., St. Louis, Mo.

RESULTS OF 1967 RESEARCH ON CONCEPTUAL FLUTTER ANALYSES Final Report, Dec. 1966–Dec. 1967

M. A. Ferman and T. E. Head 27 Dec. 1967 107 p refs
(Contract N00019-67-C-0213)
(F971; AD-665013)

Research relating to the flutter of swept wings with trailing edge control surfaces and that relating to chordwise bending flutter were continued. New research was initiated on the study of wing-pylon-store flutter. TAB

N68-27454*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

FINITE ELEMENT MODELLING OF THREE-DIMENSIONAL STRUCTURES

William R. Case, Jr. May 1968 36 p refs
(NASA-TM-X-63238; X-321-68-158) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A three-dimensional finite element originally devised by A. Hrennikoff has been used to determine its accuracy in predicting the deflections, stresses and strains of an elastic continuum. This finite element model is of rectangular parallelepiped shape and is essentially a constant stress–strain element. In order to gauge its accuracy, a classic problem in three-dimensional elasticity with a known closed form solution was selected and this structure was modelled with the Hrennikoff finite element. The problem selected for this initial investigated was that of a prismatical bar stretching due to the action of its own weight. The results of the finite element analysis show excellent agreement with the theory even for a very coarse mesh size subdivision of the prismatical bar thereby indicating that the Hrennikoff finite element model can be used with confidence to model three-dimensionally elastic structures. Limitations on the application of this element are indicated in the text. Author

N68-27533*# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.

STRESS CONCENTRATION IN A RUBBER SHEET UNDER AXIALLY SYMMETRIC STRETCHING

Wei Hsuin Yang Dec. 1966 28 p refs Presented at the ASME Conf., Pasadena, 26–28 Jun. 1967
(Grant NsG-172-60)
(NASA-CR-80979; GALCIT-SM-66-16) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A class of axially symmetric problems concerning a highly elastic circular rubber sheet with: (1) a centered circular hole or (2) a rigid circular inclusion under outward radial loading at outer boundary, and (3) a rigid outer boundary and a concentric hole under inward radial loading around the hole are solved. The differential equation governing the deformation is formulated under the assumptions of plane stress and incompressible, initially isotropic material and is integrated in the plane of principal stretch ratios.
Author

N68-27545*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE MECHANISMS AND SCALING OF DAMPING IN A PRACTICAL STRUCTURAL JOINT

Brantley R. Hanks and David G. Stephens [1966] 26 p refs Presented at the 36th Shock and Vibration Symp., Los Angeles, 18–20 Oct. 1966
(NASA-TM-X-59959) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An investigation was conducted to determine the effect of geometric scale on the damping in a practical beam-joint assembly. A cantilever configuration was utilized wherein the beam was bolted between two angle brackets at the support. Four geometrically similar assemblies, covering a scale range of approximately twenty to one, were tested. Free decay of the fundamental mode was measured over a range of joint clamping pressures and beam tip amplitudes. Also, damping changes resulting from the addition of liquid lubricants and viscoelastic films to the joint interfaces were investigated. Data indicate that an increase in model size results in a decrease in damping attributed to the structural joint. Furthermore, joint damping is shown to be slightly dependent on vibration amplitude and to vary as an inverse function of joint clamping pressure. Joint damping may be substantially increased by the addition of liquid lubricants or viscoelastic films at the joint interfaces. Author

N68-27561*# Northwestern Univ., Evanston, Ill. Dept. of Civil Engineering.

INSTABILITY OF A MECHANICAL SYSTEM INDUCED BY AN IMPINGING FLUID JET

Walter T. Feldt, S. Nemat-Nasser, S. N. Prasad, and George Herrmann Apr. 1968 45 p refs
(Grants NsG-605; NGR-14-007-067)
(NASA-CR-95225; TR-68-2) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This study is concerned with the theoretical and quantitative experimental determination of critical loads which separate stable from unstable states of equilibrium of a mechanical system subjected to an impinging fluid jet. It was found that the type of stability loss is determined by the properties of the surface upon which the jet impinges. For a smooth surface, stability was lost by divergence (static buckling), whereas for a surface with a screen of certain mesh size, stability was lost by flutter (oscillations with increasing amplitudes). The experimental results were compared with a theoretical stability analysis of this nonconservative system. Satisfactory correlation of numerical values is shown to exist, particularly if the peculiar effects of damping are accounted for. Author

N68-27586# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RUPTURE OF A BODY WITH LINEAR DISLOCATION [RAZRYV TELA S LINEYNOY DISLOKATSIYEY]

M. Ya. Leonov and K. N. Rusinko *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 129–139 refs (See N68-27575 16-23)

Brittle rupture of an unbounded body with introduced material half-plane is investigated (edge dislocation) during its uniform extension to infinity by forces perpendicular to the shown half-plane. The basic purpose of this work is clarification of the influence of different laws of interaction of opposite edges of cracks on conditions of brittle rupture. Author

N68-27587# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STUDY OF DESTRUCTION OF BRITTLE BONDINGS BY METHODS OF THE THEORY OF CRACKS [IZLUCHENIYE METODAMI TEORII TRESHCHIN RAZRUSHENIYA KHRUPKIKH SKLEYEK]

B. M. Malyshev and R. L. Salganik *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 141–158 refs (See N68-27575 16-23)

Analytical and experimental investigations were carried out to determine the mechanism of fracture propagation in homogeneous as well as nonhomogeneous materials spliced together by resins. Equations are given describing the normal and tangential stresses generated at the cut between two elastic bodies which, outside the cut, are in complete cohesion. These stresses are shown to be functions which depend on the shear moduli and Poisson coefficients of the material. From these two expressions, a functional equation is obtained for the fracture energy of a cut or slit. To verify this result experimentally, three simplified fracture (or tear) schemes are introduced. All three cases were tested experimentally by using plastic-on-plastic and plastic-on-steel splices with epoxy resin bonds. Author

N68-27588# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE THEORY OF THE AXIALLY SYMMETRIC STATE OF AN IDEAL PLASTIC MATERIAL [K TEORII OSESIMMETRICHNOGO SOSTOYANIYA IDEAL'NO-PLASTICHESKOGO MATERIALA]

G. I. Bykovtsev, D. D. Ivlev, and T. N. Martynova *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 159–169 refs (See N68-27575 16-23)

In this work are considered equations of the axially symmetric problem of an isotropic ideal plastic material when the stressed and deformed state corresponds to the edge of an arbitrary piecewise-linear surface of fluidity. It is shown that in this case the initial system of equations always has real characteristics, coinciding with trajectories of main stresses (isostatic curves). It is shown that there cannot exist a line of discontinuity of rates of displacements. Let us note that if in the case of conformity of the stressed and deformed state to edge of surface of fluidity the problem is statically definable, then for the edge of the surface of fluidity there is always kinematic definability. The last for the condition of plasticity of Tresca was noted. The work considers also self-simulating solutions, corresponding to conical and spherical flows of ideal plastic material. Considerations are made that the stressed and deformed state, corresponding to an edge of a prism of fluidity, cannot correspond to basic types of axially symmetric flows of ideal plastic material. Author

N68-27589# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORY OF VISCOELASTIC MULTILAYERS OF SHELLS WITH RIGID FILLERS WITH THE EXISTENCE OF FINITE BENDING [TEORIYA VYAZKO-UPRUGIKH MNOGOSLOYNYKH OBOLOCHEK S ZHESTIKIMI ZAPOLNITELYAMI PRI KONECHNYKH PROGIBAKH]

E. I. Grigolyuk and P. P. Chulkov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 171–183 refs (See N68-27575 16-23)

The theory of finite deflection of multilayer sandwich shells is developed. The arbitrarily alternated load carrying layers and the filler layers are both made of different viscoelastic materials, and they are laterally incompressible and rigidly joined with each other. The theory is based on the equations for shallow shells, assuming a linear variation of displacements over the thickness of the whole pack. The accepted modified Kirchhoff–Love hypothesis (that the straight fibers originally normal to the surface of the shell remain straight under deformation, but not normal to the distorted surface) permits one to consider shifts in the material of the layers. Two solving differential equilibrium equations containing the displacement and force functions are set up; the systems of equations for various particular cases (rigid-core and light-core sandwich plates) are obtained from these equations. The application of these equations to investigating vibrations of thin, shallow, multilayer shells is indicated. The formulation of basic boundary conditions for simply supported and clamped shallow shells is given. Author

N68-27606*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ACCURACY STUDY OF FINITE DIFFERENCE METHODS IN STRUCTURAL ANALYSIS

Nancy Jane Cyrus and Robert E. Fulton [1966] 26 p refs
Presented at the 4th Conf. on Electron. Computation Am. Soc. of Civil Engr., Los Angeles, 7–9 Sep. 1966
(NASA-TM-X-59958) CFSTI: HC$3.00/MF$0.65 CSCL 20K

An accuracy study is made of central finite difference methods for solving boundary value problems in structural analysis which are governed by equations with variable coefficients leading to odd order derivatives. Two methods are studied through application to beam-columns with nonuniform inplane loads and nonuniform stiffness. Definitive expressions for the error in each method are obtained by using Taylor series to derive the differential equations which exactly represent the finite difference approximations. The resulting differential equations are accurately solved by a perturbation technique which yields the error directly. A "half station" method, which corresponds to making finite difference approximations before expanding derivatives of function products in the beam-column differential equations, was found clearly superior to a "whole station" method which corresponds to expanding such products first. Author

N68-27613*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STRAIN RESPONSE OF SIMPLY SUPPORTED BEAMS TO POINT AND ACOUSTIC LOADING

Tony L. Parrott and Joseph A. Drischler [1966] 25 p refs
Presented at the 36th Shock and Vibration Symp., Los Angeles, 18–20 Oct. 1966
(NASA-TM-X-59967) CFSTI: HC$3.00/MF$0.65 CSCL 20K

Compared are measured and predicted strain responses for carefully controlled experiments whose boundary conditions approximate simple support to a high degree. This type of boundary condition was found readily amenable to mathematical analysis and to be characterized by low damping. Considerable effort was required to perfect beam-boundary attachments having satisfactory simple support behavior. The beams were of cold-rolled steel, with dimensions chosen in such a way that significant vibration amplitudes (in excess of the beam thickness) could be obtained in the fundamental mode. Beam attachments consisted of .004-in-thick right-angle supports of stainless steel shimstocks welded to each end of the beam and clamped in a mount. The beams were excited by both sinusoidal and random loadings applied both acoustically (uniformly distributed) and mechanically (at a point). In addition to strain, total equivalent viscous damping and the magnitude of the exciting force were measured. Good agreement exists between measured and predicted dynamic bending strain, but the theory overpredicted for sinusoidal point loading and underpredicted the dynamic strains for sinusoidal acoustic loading. Theory and experiment closely agree for random loading. Total equivalent viscous damping, measured by the log decrement technique, was found to have amplitude and modal dependence. K.W.

N68-27624 Texas A&M Univ., College Station.

STRESS–STRAIN ANALYSIS OF A THREE DIMENSIONAL LOOSE ARRAY OF ELASTIC EQUIRADII SPHERES

James Clyde Armstrong (Ph.D. Thesis) 1967 151 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-9771

A stress-strain analysis was performed on a three dimensional loose array of elastic equiradii spheres subjected to triaxial and one dimensional compression conditions. A review is presented of available information which was gained from literature relating the application of particulate mechanics to arrays of elastic equiradii spheres. The principles and equations of particulate mechanics were applied to the loose array and deformation equations were developed to explain both vertical and horizontal movement. The strains both vertically and horizontally were determined as the vertical stress was incremented. A parametric study was conducted to determine the effect of particle parameters on the deformation characteristics of the array of spheres. The results of the parametric study were analyzed, and the families of stress-strain curves compared to actual stress-strain curves of real granular soils. Dissert. Abstr.

N68-27628 Brown Univ., Providence, R. I.

TWO INVESTIGATIONS IN FINITE ELASTICITY. 1: LARGE DEFORMATION ANALYSES OF BONDED ELASTIC MOUNTS. 2: ON A CLASS OF SOLUTIONS IN PLANE FINITE ELASTICITY

Werner Walter Klingbeil (Ph.D. Thesis) 1967 118 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-2255

Approximate theoretical analyses are presented for the large deformation in compression and extension of elastic mounts in the form of infinitely long rectangular bars and of circular disks bonded between parallel rigid end-plates. The results are compared to published experimental observations on mounts of soft gum rubber and are found to be in good agreement over a wide range of thicknesses and applied strains. The load-deflection behavior is discussed in detail and the dependence of the maximum hydrostatic mean stress on the mount geometry and applied strain is illustrated. Elastic deformations in plane strain are considered for which the stresses are functions only of a polar angle. The solution of stress boundary-value problems for wedge-shaped regions is investigated in detail, with the results for infinitesimal deformation assessed and extended by non-linear treatments for incompressible materials. Dissert. Abstr.

N68-27630 Washington Univ., Seattle.

THE EFFECT OF INPLANE EDGE RESTRAINT ON THE VIBRATION AND FLUTTER OF SLIGHTLY CURVED PANELS

Clark Emmett Lemley, Jr. (Ph.D. Thesis) 1967 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-9388

Panel flutter is an oscillatory aeroelastic instability that is similar in some respects to the better known flutter of lifting surfaces. A significant difference is, however, that panel flutter is only of concern when the Mach number exceeds one. The unresolved problem areas are generally considered to be structural rather than aerodynamic. Real structures, and especially those that are plate-like in nature, very often fail to behave in the manner predicted from the analyst's mathematical models. Anomalous vibration and flutter results from tests of a nominally flat panel that were obtained by another investigator could not be explained by any theory that assumed the panel to be perfectly flat. This dissertation describes the author's investigation of the panel and its flexure support with the result that both the vibration and flutter behavior were found to be due to the effect of elastic, inplane edge restraint combined with initial curvature. Dissert. Abstr.

N68-27631 Rensselaer Polytechnic Inst., Troy, N. Y.

VIBRATIONS OF CIRCULAR CYLINDERS OF ISOTROPIC FOUR CONSTANT MATERIAL

Aavo Merend (Ph.D. Thesis) 1966 66 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-9290

A study is made of the modes of vibration of an infinitely long cylinder composed of an isotropic material which exhibits the phenomenon of couple-stress. The lateral surface of the cylinder is assumed to be unloaded. Equations of motion are derived from a consideration of forces and couples acting on an element of the cylinder. Constitutive equations, generalized from the linear equations of classical elasticity, are stated and are used to express the equations of motion in terms of displacements. Displacement functions satisfying the equations of motion are derived for torsional, longitudinal and flexural vibration modes. The requirement of traction free lateral surface is used to develop frequency equations for each of the three types of vibration. Numerical computations are carried out in the case of torsional and longitudinal vibrations in order to investigate the effect of couple-stress on the velocity of wave propagation and to determine the radial variation of displacements across a section of the cylinder. Dissert. Abstr.

N68-27704# Naval Research lab., Washington, D. C. The Shock and Vibration Information Center.

THE SHOCK AND VIBRATION BULLETIN, NO. 37, PART 6

Jan. 1968 83 p refs Papers presented at the 37th Symp. on Shock and Vibration, Orlando, Fla., 24–26 Oct. 1967
(AD-668328)

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N68-27705# Army Aviation Material Labs., Fort Eustis, Va.

HELICOPTER VIBRATIONS

Charles D. Roach *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 1–3 (See N68-27704 16-32)

Of all mechanical contrivances, the helicopter probably experiences the greatest variety of unpredictable loads. The problems presented by the full range of mechanical vibrations to which the helicopter is subjected are eclipsed by the almost overwhelming complexity of the aerodynamically induced vibrations. While computers have eased the profound problem of delineating the aerodynamic forces and moments on a rotating blade translating through the air at a small obliquity, theories of general applicability, or known limitations, have yet to be devised. Much of the difficulty derives from the inability to handle either incompressible or compressible fluid flow. A summary is given of the multitude of vibration problems despite which the helicopter continues to be accepted. Current studies may enable much better definition of the aerodynamics of the rotor throughout the operating range. Flow control, better management of pitch variations, better airfoil designs, and boundary-layer control may be possible. Vibration isolation will still be required. Author

N68-27706# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

HELICOPTER VIBRATION—A MAJOR SOURCE, ITS PREDICTION, AND AN APPROACH TO ITS CONTROL

Richard P. White, Jr. and Frank A. Du Waldt *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 5–17 refs Sponsored by Army (See N68-27704 16-32)

Techniques for predicting blade loads are reviewed with the intent of illustrating the importance of nonuniform downwash and the blade vibratory characteristics in the production of vibratory loads transmitted to the helicopter fuselage. One possible method of controlling the transmitted vibration is through the application of harmonic pitch control to the rotor system. The benefits that can be theoretically gained through the use of various orders of harmonic pitch control are illustrated by results obtained from a research program performed by Cornell. The reliability of present analysis techniques in predicting the transmitted shear will be evaluated in terms of the state of the art in predicting (a) the nonuniform downwash field in which the rotor operates and (b) the vibratory characteristics of the rotor system. Author

N68-27707# Boeing Co., Morton, Pa.

HELICOPTER FUSELAGE VIBRATION PREDICTION BY STIFFNESS MOBILITY METHODS

John J. Sciarra *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 19–28 refs (See N68-27704 16-32)

Through the use of the direct stiffness and mobility methods, many aspects of a helicopter fuselage's dynamic characteristics may be investigated. The objective of such studies would be to economize on flight tests, and also to yield insight as to inflight vibration response reduction methods. For many years, helicopter fuselages have been idealized and analyzed by use of the stiffness method. The results were natural frequencies, mode shapes, and the forced vibratory response. Correlation was good. It was then observed from this analysis and by test that certain natural frequencies of the fuselage could be altered by structural modification to yield a lower vibratory response. More recently, a crudely idealized model of a helicopter fuselage was dynamically analyzed by using the stiffness method. Results were compared with those obtained for a refined model. Agreement indicated that preliminary vibratory design of fuselages was feasible in the proposal stage. The stiffness method was then extended to allow for the analysis of the effectiveness of antivibration devices by using mobility techniques. It was found that by using this mobility method, the analysis of the effectiveness of antivibration devices at the point of attachment, and at remote points, compared well with testing. Author

N68-27708# Barry Wright Corp., Watertown, Mass.

ISOLATION OF HELICOPTER ROTOR-INDUCED VIBRATIONS USING ACTIVE ELEMENTS

Peter C. Calcaterra and Dale W. Schubert *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 29–37 refs (See N68-27704 16-32)
(Contract DA-44-177-AMC-472(T))

Vibratory helicopter rotor-induced forces contain energy at frequencies which are harmonics of the blade passage frequency and typically occur in the range of 10 to 30 Hz. Results of an investigation are presented which demonstrate the feasibility of providing virtually 100 percent isolation of rotor-induced vibratory forces at the blade passage frequency, b/rev, and its second and third harmonics, while limiting the relative deflection between rotor and fuselage during normally encountered maneuver loads (1.5 to 2 g) and landings (2 to 3 fps) to less than 1/8 in. The analysis considered helicopter gross weights ranging from 13 to 26 Hz. Vibration isolation is provided in all cases by electrohydraulic isolators (consisting of a hydraulic cylinder, acceleration and displacement feedback sensors, and servo amplifier) designed to be compliant only at the b/rev and second and third harmonics. Displacement control is achieved by the system because of its noncompliance at all other frequencies. Author

N68-27709# Bolt, Beranek, and Newman, Inc., Los Angeles, Calif.

HYBRID VIBRATION-ISOLATION SYSTEM FOR HELICOPTERS

David Alan Bies and Thomas M. Yang *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 39–47 ref (See N68-27704 16-32)
(Contract DAAJ02-67-C-0082)

A feasibility study of a vibration-isolation system which combines the functions of an active and a passive system was made. The isolator assembly was actively controlled at low frequencies and passively controlled at high frequencies. Two possible modes of operation were considered. Preliminary results of this investigation are reported. Author

N68-27710*# Kaman Aircraft Corp., Bloomfield, Conn.

RECENT ADVANCES IN THE STUDY OF SYNCHRONOUS VIBRATION ABSORBERS

A. V. Srinivasan *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 49–55 refs (See N68-27704 16-32)
(Contract NASw-1394) CSCL 20K

Theoretical and experimental results of a study of two gyroscopic configurations as synchronous vibration absorbers are discussed. One configuration discussed, the "Perissogyro" vibration absorber, consists of a gyrodisk at one end of a shaft, the other end of which is connected to a cross pivot. The disk, drive system, and cross pivots rotate in unison. The two translational degrees of freedom are (a) along X, the direction of excitation, and (b) along Y, perpendicular to X. The theoretical and experimental analyses provide for a spring rate along Y. Two distinct nulls are predicted by theory. During experimentation it was found that the higher nulls could not be detected easily, although a tendency toward reaching a higher null was noticeable. It is shown that while a null can always be obtained in the direction of excitation, oscillations will always occur in an orthogonal direction. In the second configuration, which is essentially a top, the gyro disk rotates in relation to the shaft on which it is mounted. The shaft itself is mounted on a cross pivot so that the device may oscillate in two directions perpendicular to each other. Author

N68-27711*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

OPTIMIZING THE DYNAMIC ABSORBER TO INCREASE SYSTEM DAMPING

Gary K. Jones *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 57–62 refs (See N68-27704 16-32) CSCL 20K

Technical problems encountered in the operation of the Orbiting Geophysical Observatory (OGO) II spacecraft called for an investigation of the dynamic characteristics of the dynamic absorber. When properly tuned and damped, the dynamic absorber, which consists of the damped spring-mass system, has the effect of reducing the transmissibility and increasing the modal damping of the system to which it is attached. The main purpose of this investigation was to define analytically the effect on system damping produced by the dynamic absorber. A mathematical model which consisted of a damped dynamic absorber attached to the mass of a simple spring-mass system was used. The differential equations of motion for the system were derived. The characteristic equation was formed and solved for various values of system parameters with a digital computer program. For a given set of parameters, two values of modal damping were determined. The results of the investigation indicated that the value of absorber damping which optimizes modal damping is 163 percent of that which optimizes transmissibility. The results also indicated that the optimum value of absorber tuning is the same with respect to transmissibility and modal damping. Both tuning and damping errors were found to produce significant changes in modal damping. Author

N68-27712# Kaman Aircraft Corp., Bloomfield, Conn.

APPLICATION OF THE DYNAMIC ANTIRESONANT VIBRATION ISOLATOR TO HELICOPTER VIBRATION CONTROL

Robert Jones and William G. Flannelly *In* NRL The Shock and Vibration Bull., No. 37, Pt. 6 Jan. 1968 p 63–81 refs
Sponsored by Army (See N68-27704 16-32)

Experimental and analytical investigations of the dynamic antiresonant vibration isolator (DAVI), an inertially coupled isolation device which permits a high degree of isolation at discrete low frequencies without sacrifice of elastic stiffness, are reported. The principles upon which the DAVI is based and laboratory experimentation on a DAVI isolated helicopter pilot's seat are described. The effects of shock inputs and damping on DAVI performance are shown through analysis and experiment. The need for two-dimensional DAVI action in multidirectional excitation environment is demonstrated by the results of the helicopter flight testing of a unidirectional DAVI platform. Laboratory test results are presented to show the independence of DAVI isolation from the weight of the isolated item, clearly violating the "static deflection rule" of conventional isolators. The principles of the family of series-damped DAVI's are outlined, and experimental confirmation of the capability of the series-damped DAVI's for passively producing a damped resonance and a completely undamped antiresonance is presented. A summary of work now underway on the application of DAVI to helicopter rotor isolation reveals unique possibilities for the alleviation of rotor-induced vibration in helicopters. Author

N68-27728 Texas A&M Univ., College Station.

A DISPLACEMENT ANALYSIS FOR SYMMETRICALLY LOADED PLANE ANISOTROPIC SHELLS OF REVOLUTION

Donald Thompson Hunter (Ph.D. Thesis) 1967 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-9791

A displacement analysis for a thin, plane anisotropic shell with symmetrical loading is obtained with the use of Sanders' improved first-approximation theory. The analysis leads to a set of three simultaneous, ordinary, differential equations with variable coefficients, the solution to which yields the shell middle surface displacements u, v, and w. A semi-infinite, cylindrical shell with edge loadings is investigated to illustrate the method of solution. A set of closed form solutions for this case is obtained, demonstrating that the solutions to the differential equations derived depend upon the degree of plane anisotropy of the shell. A discussion of these solutions is presented for the cases of weak, strong, and mixed plane anisotropy. Dissert. Abstr.

N68-27735 Connecticut Univ., Storrs.

THE VIBRATION AND ACOUSTIC RADIATION OF A SIMPLY SUPPORTED PLATE EXCITED BY TURBULENT BOUNDARY LAYER PRESSURE FLUCTUATIONS

Robert Douglas Collier (Ph.D. Thesis) 1966 175 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-4536

A general method of analysis for predicting the vibration acceleration response and correlation functions of a simply supported flat plate under an assumed turbulent boundary layer pressure excitation correlation function is developed. The form of the pressure correlation function permits the theoretical evaluation of the plate statistical acceleration characteristics in terms of the boundary layer characteristics and plate modal response functions. Computer programs have been prepared and examples are given using a dimensional analysis of the plate acceleration correlation coefficients for individual and summed modes, including the case of the product of unequal modal functions. The theoretical analysis of the acoustic radiation field is developed in which the plate acceleration correlation functions are used to obtain the acoustic pressure cross and autocorrelations. Dissert. Abstr.

N68-27736 Kansas State Univ., Manhattan

STRESSES IN PLANE NONHOMOGENEOUS ELASTIC BODIES

James Revell Kimzey (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9143

This dissertation considers the problem of plane nonhomogeneous elasticity. The governing differential equations are derived in rectangular and polar coordinates in terms of both the stress function and displacement formulation. The equations are variable coefficient, linear partial differential equations. The variable coefficients describe the nonhomogeneity of the elastic body under consideration. Solutions are presented for the stress function formulation in polar coordinates under the assumptions of constant

Poisson's ratio and nonhomogeneity in the radial direction. The solutions are found by using the general power series method of Frobenius. A particular group of boundary conditions is discussed and the arbitrary constants of the solutions evaluated in general for this group of conditions. Numerical examples are presented for several descriptions of the nonhomogeneity and two different boundary conditions. Dissert. Abstr.

N68-27746*# Alabama Univ., University. Engineering Mechanics Research Inst.

NETWORK-TOPOLOGICAL FORMULATION OF ANALYSES OF GEOMETRICALLY AND MATERIALLY NONLINEAR SPACE FRAMES

J. T. Oden and Alice Neighbors (NASA. Marshall Space Flight Center) [1966] 33 p refs Submitted for publication
(Grant NsG-381)
(NASA-CR-75506) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This paper presents a network-topological formulation of the matrix force method for computer analysis of space frames. The automatic selection of redundant forces is accomplished by using linear graph theory, corresponding to the mesh method of network analysis. Nonlinear effects of large deformations and material nonlinearity are incorporated through use of interactive procedures. The equations of the formulation are given and examples are included to demonstrate the method. Author

N68-27748# Royal Aircraft Establishment, Farnborough (England).

MAMA—A SEMIAUTOMATIC TECHNIQUE FOR EXCITING THE PRINCIPAL MODES OF VIBRATION OF COMPLEX STRUCTURES

G. A. Taylor, D. R. Gaukroger, and C. W. Skingle Aug. 1967 35 p refs
(RAE-TR-67211) CFSTI: HC $3.00/MF $0.65

The paper describes equipment designed to control a number of exciters in a resonance test. The equipment was developed as the result of experience with an earlier system in which both the frequency of excitation and the force distribution between the exciters were controlled automatically. In the MAMA system, the frequency is controlled automatically but the force distribution is found by a manual iterative procedure. The equipment enables generalized inertias to be determined by force input variations. Also exciter characteristics can be compensated so that they do not affect the modes of the structure. Author

N68-27749# Royal Aircraft Establishment, Farnborough (England).

THE FORMULATION OF AN INFLUENCE COEFFICIENT METHOD FOR DETERMINING STATIC AEROELASTIC EFFECTS, AND ITS APPLICATION TO A SLENDER AIRCRAFT IN SYMMETRIC FLIGHT AT $M = 2.2$

A. S. Taylor and D. J. Eckford Sep. 1967 84 p refs
(RAE-TR-67237) CFSTI: HC $3.00/MF $0.65

This report presents a matrix formulation of a method which employs influence coefficients to solve static aeroelastic problems. Linear structural characteristics are assumed and the aerodynamic loading, including that due to elastic deformation, is assumed to be compounded from a linear combination of 'elementary' distributions. Details of the method are here considered only for symmetric flight cases, though in essence it is universally applicable. The method has been applied to a Concord-like supersonic transport aircraft in symmetric flight at $M = 2.2$. Linearized supersonic theory has been used to derive the load due to elastic deformation. Results are presented for the incidences and elevator angles to trim and to sustain quasi-steady maneuvers, for the longitudinal distributions of shear force and bending moment, and for the elastic deformation acquired. Author

N68-27827 Virginia Polytechnic Inst., Blacksburg.

GENERALIZED RING BOUNDARY CONDITIONS FOR SHELLS OF REVOLUTION

George Eliot Weeks (Ph.D. Thesis) 1967 159
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-7391

A generalized set of nonlinear boundary conditions are derived for a shell of revolution with a ring of arbitrary cross section attached to its boundary in an arbitrary manner. They are derived by formulating the total potential energy of the ring in terms of the shell variables and applying the principle of minimum potential energy. Shear deformation, internal pressure, eccentricity, warping, torsion, and prestress in the ring are included. External loadings on the ring are not considered. A perturbation method is used to obtain a set of linear equations from the nonlinear boundary conditions. The results are applicable to the shell problems of either stress analysis or stability. Detailed results are presented in order to illustrate the effect of prestress, shear deformation, eccentricity, and wave number of the ring on the stiffness characteristics of the ring. Dissert. Abstr.

N68-27832 Kansas State Univ., Manhattan.

FREE VIBRATION OF CONICAL SHELLS

Thomas George Swaney (Ph.D. Thesis) 1967 55 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-9154

This dissertation considers the problem of the free vibration of a truncated conical shell with arbitrary boundary conditions. The governing differential equations of motion for the shell are derived from the classical shell theory. After a linear transformation to shift the origin from a singular point to an ordinary point, the governing system of equations is solved in terms of power series. The linear independence of the solutions is guaranteed by the judicious choice of eight arbitrary coefficients from the power series expansions. The existence and convergence of the power series solutions is shown by application of a theorem from differential equation theory. Application of the boundary conditions in an attempt to determine the eight arbitrary constants of integration leads to a homogeneous system of equations. A non-trivial solution of this system requires that the determinant of the coefficient matrix be zero. The infinite set of values which make this frequency determinant zero are the natural frequencies of the vibrating system corresponding to the prescribed boundary conditions. Dissert. Abstr.

N68-27849# Hawker Siddeley Aviation, Ltd., Hatfield (England).

THE IMPORTANCE OF SERVICE INSPECTION IN AIRCRAFT FATIGUE

J. A. B. Lambert and A. J. Trough [1967] 39 p refs Presented at the 5th ICAF Symp., Melbourne, 22–24 May 1967
CFSTI: HC $3.00/MF $0.65

The advantages and disadvantages of safe-life and fail-safe structures are discussed, and the cost significance of several parameters associated with aircraft structural design is evaluated. It is pointed out that unexpected cracks in service due to accidental damage or corrosion have led to the development of the fail-safe structure to protect against these hazards, an advantage which the simple safe-life structure cannot provide. Nondestructive testing methods for aircraft structures in service are reviewed, including visual, magnetic crack detection, X-ray, eddy current detectors, and ultrasonic techniques. The limitations and effectiveness of each method are assessed. It is concluded that in a fail-safe aircraft it is vital to design a structure which can be inspected visually, and that the use of safe-life stress levels for fail-safe structures to decrease inspection is worthwhile. Other design problems are identified as the need for greater protection against corrosion, and the avoidance of such features as closed section stringers and boxed-in structures in areas which are corrosion-prone and fatigue-sensitive. M.G.J.

N68-27867# Service Technique de l'Aeronautique (Belgium).

A REVIEW OF FRENCH WORK ON FATIGUE FOR THE PERIOD 1964–1966

W. Barrois [1967] 37 p refs Presented at the ICAF Meeting, Melbourne, May 1967

Details are given on the program developed to conduct tests on smooth and notched small specimens to define and characterize each use-condition of a metal, or to study the effect of a manufacturing process. Summary data are presented on toughness bending tests conducted on square bar specimens of aluminum alloys, magnesium alloys, low alloy steels, precipitation hardened steels, and titanium alloy; and fatigue tests on smooth and notched specimens of aluminum alloys, titanium alloys, and fiber glass polyester panels. Tests conducted by aircraft manufacturers are also reported. These relate the fatigue behavior of steel bushes cold-glued into aluminum alloy components, and fatigue crack propagation in the outer skin of a honeycomb sandwich fuselage. M.G.J.

N68-27870# Sud-Aviation, Paris (France).

SOME CONSIDERATIONS ON ACOUSTIC FATIGUE

Jean G. Wagner [1967] 47 p Presented at the 5th ICAF Symp., Melbourne, 22–24 May 1967

The continual increase in aircraft performance is compelling manufacturers to give increasing attention to the problem of evaluating the fatigue life of structural elements subjected to considerable random excitation. This excitation is engendered either by turbulence or by turbojet efflux. Methods to solve the problem constitute: (1) a turbojet installation to provide a realistic excitation and study the structural response of complex components; (2) sinusoidal excitation to investigate the resonant frequencies and associated vibration modes of the same components; and (3) a noise generator (random or sinusoidal output) with an experimentation chamber reproducing various vibration spectra at a high noise level. Author

N68-27883# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.

THE EFFECTS OF MALALIGNMENT OF THE AEROELASTIC BEHAVIOR OF UNGUIDED ROCKETS

Akira Nakano Mar. 1968 24 p refs
(ISAS-421, V. 33, No. 3)

In this paper, a method to obtain the bending loads on unguided rockets due to malalignment are investigated. From perturbation equations of motion, two kinds of system equations are reduced; one is for mode analysis, another is for discrete mass analysis. After some simplifications, the load factor which represents the bending loads is expressed as the linear function of each malalignment values. Finally, as the simplest example, the behavior of single stage type rocket is studied in relation to the body divergence characteristics. Author

N68-27891*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

USE OF ANALOG COMPUTER FOR THE EQUALIZATION OF ELECTROMAGNETIC SHAKERS IN TRANSIENT TESTING

Marc R. Trubert [1968] 23 p refs
(Contract NAS7-100)
(NASA-CR-95095) CFSTI: HC$3.00/MF$0.65 CSCL 20K

A method which uses an analog computer to perform an open-loop equalization for multi-shaker environmental vibration testing is presented. The computer is programmed to simulate the equations of motion of the electromechanical system. The input of the computer is an electrical signal representing the acceleration time histories to be reproduced at the base of the spacecraft. An example of multi-shaker equalization is shown for transient testing on a beam excited at two points. The method is valid for any type of vibration testing. Author

N68-27893*# Texas A&M Univ., College Station. Space Technology Div.

THE ANALYSIS OF STRUCTURALLY ORTHOTROPIC SHELLS BY MEANS OF THE COMPLIANCE METHOD

Progress Report, Period Ending 1 Jun. 1968

Thomas J. Kozik 1 Jun. 1968 43 p refs
(Grant NGR-44-001-031)
(NASA-CR-95143) CFSTI: HC$3.00/MF$0.65 CSCL 20K

Linear shell theory elastic constant instability conditions were analyzed for symmetrically loaded shells of revolution. A classical first order derivation for a symmetrically edge-loaded, elastically plane anistropic right circular cylindrical shell was undertaken to take care of the nonsatisfaction of boundary conditions for certain combinations of elastic constants. Experiments on a full cylindrical shell are in the conceptual stage, although results are included for a rib stiffened circular cylindrical panel. General first order plane anisotropic shell equations were developed, and an engineering oriented nonlinear analysis of shell equations is being developed. In connection with the latter, the derivations for the first quadratic form, the equilibrium, and the constitutive equation were completed. Considerable difficulty was encountered in the development of the second quadratic form, principally in defining the angle of rotation for an element. M.W.R.

N68-27903*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

DAMPING OF THERMOELASTIC STRUCTURES

William Mitchell Gillis 10 Apr. 1968 57 p refs
(NASA-TM-X-53722) CFSTI: HC$3.00/MF$0.65 CSCL 20L

This report considers longitudinal waves traveling in a cylindrical rod. After a review of the classical results of wave propagation in unbounded elastic solids and in elastic cylinders, the subject of thermal modification of elastic properties is undertaken. The resultant effects upon the purely elastic wave motion consists of the change in the propagation velocity and the addition of a damping effect upon the mechanical energy of the elastic wave due to heat conduction. The thermoelastic effects upon a longitudinal elastic wave are shown to be small in terms of the propagation velocity. However, more significantly, the thermo-elastic damping effect is large for very high frequency waves traveling in small diameter bars. The behavior of the thermoelastic damping coefficient is linked to a "thermoelastic bar number," developed herein. Finally, approximations are developed, based upon the value of the thermoelastic bar number, to predict the behavior of the thermoelastic damping coefficient as a function of frequency. Author

N68-27917# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

EXPANDABLE AND MODULAR STRUCTURES CONFERENCE

May 1967 723 p refs 3d Aerospace Conf. held Miami Beach, Fla., 16–18 May 1967
(AFAPL-TR-68-17; AD-668181)

The Aerospace Expandable and Modular Structures Conference serves as a forum in which leading authorities in structures technology advance new ideas and techniques for critical discussion. The objectives of the conference were (1) to present current research and development contributions in the fields of expandable and modular structures and, (2) through the exchange and evaluation of the most advanced concepts, to simulate further advances in structures technology. For individual titles see N68-27918 through N68-27951.

N68-27919# Goodyear Aerospace Corp., Akron, Ohio. Astronautics Div.

CONCEPTS AND DEVELOPMENT OF EXPANDABLE MANNED SPACE STRUCTURES

L. Jurich and T. L. Hoffman *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 23–40 (See N68-27917 16-32)

Research programs focusing on the development of expandable structures for manned space applications are summarized. The general approach used in the development cycle planned for the Air Force D-21 experiment is reviewed. The development cycle logically embodied in the approach focuses on: (1) materials development; (2) fabrication method development; (3) preprototype structure development and test; (4) prototype structure development and test; and (5) flight hardware development and orbital test. Objectives of each of these development programs are discussed. S.C.W.

N68-27921*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FLEXIBLE REINFORCED COMPOSITE WINDOW MATERIAL

Jerry G. Williams *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 63–88 refs (See N68-27917 16-32)

Flexible reinforced composite materials were studied to determine if a flexible window compatible with the space environment could be developed. The basic approaches used in the study consisted of: (1) screening available transparent polymers and reinforcement materials; (2) parametrically evaluating the reinforcement pattern; (3) developing an end attachment concept; and (4) testing the resulting composite materials and attachments. Results indicated that a flexible window is feasible for expandable structures application. A flexible window composed of a composite material of steel or fiberglass reinforcement embedded in a transparent silicone rubber matrix showed promise; however, in view of limitations in both materials, further study is underway to determine the possibility of laminating the two materials in order to combine the desirable properties of both materials. Simulated space environment experiments conducted on flexible window elements showed no serious degradation effects on the mechanical and optical properties of the composite, and good optical resolution was observed under a 7-psi pressure differential. Existing systems for attaching the flexible window into an expandable structure were insufficient to develop the full structure capability of the composite window material. The development of improved attachment concepts is recommended. S.C.W.

N68-27923# Goodyear Aerospace Corp., Akron, Ohio.

DEVELOPMENT OF COMPOUND CURVATURE AIRMAT

James T. Harris *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 105–113 (See N68-27917 16-32)

In view of the need for new technologies and construction materials for aeronautical and terrestrial applications, especially in the area of expandable structures, a study was made to develop a method for the construction of compound Airmat material cloth which could be used, for example, in the development of a space rigidized solar concentrator. The approach used was to consider each direction, warp and fill; separately developing a technique for creating curvature in each individually; and then combining the techniques to accomplish compound curvature. A study of Airmat weaving machinery operation failed to reveal any simple methods for establishing a curvature in the fill direction similar to that achieved in the warp direction; therefore, two alternate methods offering promising solutions to the problem were investigated. These were: the variable stiffness method, and the heat setting method. Proof that the systems for creating warp curvature and fill curvature could be incorporated into Airmat cloth simultaneously was established by weaving a four foot demonstration panel incorporating both techniques into the single panel. It is further shown that the methods of differential rate weaving for warp curvature and heat setting for fill direction curvature when combined, produces compound curvature Airmat with predictable results, and that the accuracy control was sufficient for application of the material to solar concentrator mirror support structure and therefore opens a new area for Airmat structural applications. S.C.W.

N68-27924*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPANDABLE AIRLOCK EXPERIMENT FOR THE S4B WORKSHOP

F. Forbes (AFAPL), L. Jurich (Goodyear Aerospace Corp. Akron, Ohio)., A. Cormier (AFAPL), G. Reid (AMRL), J. Williams et al *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 115–143 (See N68-27917 16-32)

Objectives and technical considerations of the D-21 expandable airlock experiment scheduled for orbital flight testing on the NASA SIVB Workshop Flight AAP-2 are described. The objective of the SIVB mission is to evaluate the feasibility of using the empty shell of the spent SIVB stage to support crew operations for a 30-day orbital mission. The scope of the D-21 airlock program extends from initial human factors evaluations to establishing size and geometry of the airlock structure to final retrieval of data and definition of experiment results subsequent to orbital testing. A few of the objectives of the D-21 airlock program are: (1) to ascertain the ability of expandable structures to withstand the boost and launch phase of a typical mission profile with subsequent successful deployment in orbit; (2) to validate the successful performance of expandable materials in operational use when subjected to the total orbital space environment; (3) to demonstrate the compatibility of expandable elastic recovery materials in airlock designs with the dynamics of astronaut ingress/egress; and (4) to establish design parameters and requirements for elastic recovery airlocks for future manned orbital laboratories. A technical discussion of the following is presented: the packaging system; airlock structure assembly; pressurization system; telemetry sensors; electrical system; mounting structure; experiment control system; and data and instrumentation systems. It is concluded that: (1) the D-21 experiment hardware can meet the space experiment schedule and requirements; and (2) the experiment procedures as defined will achieve all the experimental objectives. S.C.W.

N68-27925# Goodyear Aerospace Corp., Akron Ohio.

BUCKLING RESISTANCE OF INFLATED CYLINDERS IN BENDING

A. D. Topping *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 147–165 refs (See N68-27917 16-32)

Results of additional tests designed to (1) confirm the applicability of the deep wrinkle membrane theory in assessing the maximum bending moment that an inflated fabric cylinder can carry, and (2) to study the effect of packaging on subsequent collapse resistance are reported. Cylinders were all made to the same nominal size, 5–in in diameter and with 26–in of free length between end blocks. They were also secured to wooden end blocks by two clamps at each end. Materials used were as follows (two cylinders of each, one packaged): Dacron-neoprene; metal fabric, and Mylar. For simulated packaging, each cylinder was pressed flat and creasing at the seams was avoided. For the bending test, the pressures were selected to give a nominal safety factor of 4.0 on the hoop tension. The deep wrinkle membrane theory was the only theory in reasonable agreement with experiment. The theory provided a satisfactory estimate of the maximum bending moment and inflated cylinder with $pR/Et >$ about 0.002 can carry and was superior to previously proposed theories and empirical formulas. It was also found to be basically conservative and to provide a good lower bound. It is suggested that with adequate knowledge of the mechanical properties of the material, this theory is suitable for design. Packaging and previous buckling appeared to have only a minor effect on the buckling resistance of the materials tested. The constant cross section theory gave a good upper bound for membranes with negligible flexural stiffness. S.C.W.

N68-27926# ARO, Inc., Arnold Air Force Station, Tenn.

VACUUM TESTING OF EXPANDABLE STRUCTURES AND MATERIALS

N. C. Latture, F. W. Nelms, and R. E. Southerlan *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 195–235 (See N68-27917 16-32)
(Contract AF 40(600)-1200)

Results of vacuum tests to insure that expandable structures can be deployed in a simulated space environment and that once deployed they can withstand the space environment; are reported. Capabilities of the following three Aerospace Environmental Facility (AER) test chambers are evaluated: (1) AEC Mark I, Aerospace Research Chamber (ARC) (12V); and ARC (7V). Inflatable, self-rigidizing structures which are characterized by a fabric substrate were tested in the ARC (12V). A 10-foot diameter by 25 foot long expandable, cylinder-type aerospace shelter and an inflatable crew transfer tunnel were tested in the Mark I chamber. Since many expandable structures will be subjected to low pressure and to the combined environments of low pressure and solar radiation, rigidized fiberglass samples were tested in ARC (7V) under simulated orbital conditions to determine these combined effects. Three of the four scale model space shelter tests were successful (i.e., deployment and rigidization were accomplished). Deployment of the large aerospace shelter in a simulated space environment was not successful; however, the shelter was rigidized at atmospheric conditions. Canister separation, deployment, and pressurization of the tunnel in a simulated environment of 10^{-5} was successful. Rigidized fiberglass of the type tested was not adversely affected by the combined environmental effects of vacuum and solar for the simulated 60 day orbital period. S.C.W.

N68-27930*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

BURSTING STRENGTH OF FILM AND FABRIC PLASTIC CYLINDERS CONTAINING AN AXIAL SLIT

Jerry W. Deaton *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 255–281 refs (See N68-27917 16-32)
(L-5483)

A comparative study of the residual tensile strengths of film and fabric forms of a material in the presence of a slit is reported. Results are presented on the effect of varying slit lengths on the bursting strength of cylindrical shells made from polyethylene terephthalate film and fabric. In addition, the bursting strengths of the film and fabric cylinders are compared with the predicted results obtained from two different procedures that are currently used to predict the bursting strength of pressurized metal cylinders containing cracks. Results demonstrate that the fabric material is superior to the film material in regard to residual strength in the presence of a slit. It has been shown that the strength-weight ratio of the fabric cylinders is approximately twice that of the film cylinders largely due to the inherent strength advantage of fiber over film. Results were compared with the predicted bursting strength obtained from two different semiempirical analyses, one based on notch strength analysis and the other employing fracture mechanics concepts. The comparison demonstrates that large errors can result from the application of the notch strength analysis to film or fabric cylinders whereas the fracture mechanics analysis yields a scatter band which is consistent with the data scatter and follows the trend of the data. Although the fracture mechanics analysis describes the overall behavior, the width of the scatter band is sufficiently large such that substantial errors can result by using this method. S.C.W.

N68-27931# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

ZERO-G SIMULATION AND ITS RELATIONSHIP TO SPACE EXPERIMENTS

Gary B. Reid (AMRL) and Daniel R. Seger *In* its Expandable and Modular Struct. Conf. May 1967 p 285–298 refs (See N68-27917 16-32)

Techniques for achieving or simulating zero g are discussed, and their applicability in the design and procedures determination for the D-021 and D-023 space structure experiments is reviewed. The three primary methods used in simulating zero g are: aircraft flying keplerian trajectories, water immersion to attain neutral buoyancy, and mechanical simulators consisting of frictionless platforms with gimballed support structure. Of the three types, only two, zero g aircraft and neutral buoyancy, were used extensively. The simulation effort was primarily applied to minimize operational difficulties involved with the D-021 (Expandable Airlock Experiment) and D-023 (10-ft diameter parabolic antenna) experiments. The Expandable Airlock Experiment (D-021) consists of an expandable airlock module complete with an instrumentation system capable of monitoring all aspects of the experiment. The simulation effort was directed primarily toward solving problems associated with the ingress/egress operation. In addition, an emergency retrieval procedure was developed. The zero g aircraft will be used in the D-021 experiment primarily to validate the ingress/egress procedures, the handhold locations, and hatch actuation. The second experiment simulated consists of a modularly assembled 10 foot diameter parabolic antenna. The experiment, designated D-023, is planned to be assembled inside the SIVB tank by a crewman in a pressurized suit. Improvements resulting from simulation are discussed. No zero g aircraft simulation was performed on the D-023 experiment due to the inability of the assembled structure to sustain the 2 g loading encountered in the flight profile. S.C.W.

N68-27932# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.

DEVELOPMENT OF SELF-SEALANT TECHNIQUES FOR MICROMETEOROID PROTECTION OF AEROSPACE VEHICLES

S. Schwartz, A. J. Tuckerman, and W. F. Anspach (AF Mater. Lab.) *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 299–315 refs (See N68-27917 16-32)

In view of the potential hazards of micrometeoroids on spacecraft and expandable structures in space environments, several broad classes of sealant package systems were studied in an attempt to reduce the effects of spacecraft/meteoroid collisions. The sealant systems studied included: (1) materials which formed a seal by mechanical or other physical means; (2) those which formed seals through chemical reaction initiated by penetration of two reactant packages; and (3) those which used a combination of physical–chemical and mechanical techniques, such as hardening by solvent loss and the use of mechanical plugging devices. Package design considerations focused on the development of a system which would: (1) result in minimum damage from the shock wave and also allow minimum loss of fluid after impact; (2) permit flow of the fluids to the entry hole while restricting flow to the exit hole; and (3) be compatible with conventional methods of spacecraft fabrication such as bonded honeycomb and skin construction and/or skin and stringer construction. Two component (polyurethane reactants) and single component (water–resin emulsions) systems were studied. Presented are results of impact tests for these two systems. Results indicate that: (1) the single component self-sealant system appeared to be the simplest and most practical system to minimize the loss of pressure in a spacecraft due to micrometeoroid penetration; (2) although the sealant system was developed primarily for space vehicles, it appears also to have promise for spacesuits, expandable structures such as lunar shelters, escape capsules, etc., based on preliminary tests conducted with fabric materials; and (3) the use of this system, with some additional applications development work, could prove to be a potent life saving device. S.C.W.

N68-27935# Goodyear Aerospace Corp., Akron, Ohio.

AUTOMATICALLY ERECTABLE TOWERS AND MASTS (AUTO-MAST)

J. C. Bell *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 365–388 (See N68-27917 16-32)
(GER-13195A)

Basic design concepts and potential future applications for automatically erectable towers and masts (auto-mast) are reviewed. The primary function of the auto-mast is to provide an easily erectable and retractable mast that can elevate and adequately support a payload at any intermediate height up to its fully erectable height or length. Also, the auto-mast can be modified functionally to fit a specific application. Regardless of the specific mast application, the basic configuration consists of the mast assembly, base assembly, reel mechanism deployment and erection system, pressurization system, guy assembly, and elevator platform (when needed). Basic design features which make the auto-mast design adaptable to many applications are: its minimum weight requirements; small package size; minimum erection and retraction times; versatility of operation; easy replacement and maintenance with standard tools normally available in the field; payload capability; radar reflectivity; and its building block design which allows it to be erected to great heights. Discussed are potential future applications of the auto-mast design concept in the following areas: antenna masts; retractable vertical floats; extendable lightweight floating causeways or pontoon bridges; space structures; adjustable scaffolding for the building industry; observable towers; mud and water legs for an M-113 vehicle; bumpers to facilitate docking of ships and the transfer of supplies between two ships in mid-ocean; retractable and extendable airfoils; and catapults and actuators. S.C.W.

N68-27937# Space-General Corp., El Monte, Calif.

DEVELOPMENT AND APPLICATION OF NEW MANUFACTURING TECHNOLOGIES FOR EXPANDABLE STRUCTURES

J. F. Kaville *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 403–414 (See N68-27917 16-32)

A program designed to develop new materials systems and manufacturing technologies for high strength and high temperature expandable structures is reported. To develop and demonstrate the capability of fabricating an expandable structure for space applications, a reentry, space rescue paraglider was selected. Flexible structure material consisting of nickel-chromium metal fabric was used in its construction. A significant development of this program was the special, semi-automatic, deep throat welder which was designed to make flexible, high strength seams in metal fabrics. Extensive qualification testing on this welding system showed that the weld strength exceeded 89% of the parent fabric strength for a large population of tensile test coupons at the 90% confidence level. Objectives of the program included also the testing of a number of components of the paraglider using simulated reentry loads and temperatures to prove design technology and fabrication methods. Fifteen 7 to 10 inch diameter, open ended frustrums (tapered cylinders) were fabricated including complete impregnation and ablative coating. These were tested with end closures in place at internal pressures producing the proper reinforcing fabric loading while torsion shear, and bending loads were applied both at room temperature and temperatures simulating those of the reentry regime. Results of tests on numerous components indicated that both small and large complex metal reinforced, expandable structures can be successfully fabricated using the proposed techniques. S.C.W.

N68-27938# Air Force Systems Command, Wright-Patterson AFB, Ohio.

DYNAMIC THERMOELASTIC PROPERTIES OF INFLATABLE DELTA WINGS

Samuel J. Pollock *In its* Expandable and Modular Struct. Conf. May 1967 p 415–443 (See N68-27917 16-32)

A study designed to determine the static and vibration characteristics of inflatable Airmat models at temperatures up to 650°F for various model internal pressures is reported. Studied were three 65° sweep delta wing models with a root chord length of 51.1 inches and a trailing edge span of 24.5 inches. The model structure consisted of two basic materials: woven stainless steel Airmat, and a silicone elastomer coating. The Airmat material was the basic wing structure when inflated, and the elastomer coating made internal pressurization possible. Models one and two were coated with S-2077 silicone elastomer while model three was coated with Cs-105 silicone-ceramic elastomer. On the basis of experimental and analytical studies of these inflatable Airmat delta wing structures, it is concluded that: (1) vibration calculations using influence coefficients, based on drawing a tangent to the measured deflection-load curve at the zero load point, gave satisfactory correlation with experiment; (2) shear theory predictions for the first vibration mode frequencies were lower than experiment by as much as 40% at 2 psi, but only 9% at 10 psi; (3) for deflections due to a uniformly distributed load, good agreement was obtained between shear theory predictions and experiment; (4) when inflatable structures with silicone elastomer coatings are exposed to temperatures above 500°F, and then cooled to room temperature, the coating becomes flaky and tends to crack if flexed; (5) the effects of high temperature on vibration differed for the two coatings, i.e., for the model with the CS-105 elastomer coating (with ceramic frits), the first mode frequency at 650°F was about 10% below the room temperature value; whereas for the model coated with the S-2077 elastomer, the frequency was as much as 32% above the room temperature value. S.C.W.

N68-27943# Cincinnati Univ., Ohio. Industrial Design Dept.

LIGHTWEIGHT PORTABLE SHELTERS FOR BARE BASE APPLICATIONS

James M. Alexander *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 531–549 (See N68-27917 16-32)

Summarized are three research programs focusing on the development of shelter systems for TAC (Tactical Air Command) bare base (remote base sites) applications. Basic areas of concern which were common to all shelters studied and/or developed under all three programs were: lightness of weight, low package volume, short erection time, capability with cargo aircraft and their pallet systems, and reuse capability. The three programs focused on: (1) research, design, fabrication, and field testing of 16′×32′ lightweight expandable shelters; (2) research, design, fabrication, and field testing of 50′×80′ portable aircraft maintenance dock; and (3) design, fabrication, and testing of advance modular shelters for small and medium size shelter applications. Basic research, design concepts, field and climatic test data, materials tests, and construction techniques are detailed. S.C.W.

N68-27945# Schjeldahl (G. T.) Co., Northfield, Minn. Advanced Programs Div.

A PORTABLE SHELTER WITH SOLID VERTICAL WALLS AND ROOF

L. J. Boler and J. S. Tandon *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 569–587 refs (See N68-27917 16-32)

Structural and design concepts for a frame and panel type portable shelter (16×32 ft) are presented. The proposed structure has vertical up and down rigid walls, a sloping roof for proper drainage and has conventional doors, windows and ventilators. The structure is readily expandable, collapsible, and has very light weight and low volume. The weight of the structure is of the order of 1 to 2 pounds per sq. ft. of the base area, and the estimated cost is expected to be $2 to $3 per sq. ft. Because of its light weight, it needs no substructure and the structure can be erected on uneven terrain. Design concepts for expandable shelters considered from a materials viewpoint were divided into those with rigid walls, and those covered by a flexible membrane. A survey was made of properties of materials which fit these categories. Plastic and nonplastic rigid wall materials, and composite materials were studied. Plastic and nonplastic rigid materials were found unattractive because they were too heavy and presented packaging difficulties. Composite materials evaluated included hoenycomb panels, cardboards, and paper foam laminates. Comparative weights and costs of several facing materials when combined with 0.4 inch thick urethane foam core are presented. Of the seven materials evaluated, aluminum Kraft paper aluminum laminate was selected because it is strong, fire resistant, and is obtainable in a painted condition. S.C.W.

N68-27947# Air Force Systems Command, Wright-Patterson AFB, Ohio.

EXPANDABLE SHELTER/CONTAINER FOR BARE BASE

Adam W. Cormier and David F. Ferree (USAF, Langley AFB, Va.) *In its* Expandable and Modular Struct. Conf. May 1967 p 631–639 (See N68-27917 16-32)

Reported is the initiation of a program designed to develop an expandable shelter/container for bare base applications. A bare base is defined as a base having a runway of minimum length and width, constructed of matting or otherwise stabilized taxiways, parking areas, and having a source of water. The proposed expandable shelter/container (ES/C) is a multipurpose structure featuring two modes of operation with each mode satisfying a specific requirement of the bare base. The two primary modes of operation of the bare base concept are the container mode and the shelter mode. In the container mode of operation, the ES/C will function as a transporter of cargo. The structure will be capable of being physically locked in all modes of operation and will be capable of deployment to the shelter mode of operation without removal of contents packaged in the container mode. The shelter mode of operation of the ES/C will provide hard wall housing to support various personnel functions as hygiene, workshop, kitchen, and maintenance shop. The prime structural requirement of the ES/C is a high strength-to-weight ratio. A preliminary tradeoff study was performed which considered all parameters such as cost, weight, panel function and design, environment, permeability, structural requirements, thermal requirements, and fire, fungus, rot, and mildew resistance. The material candidates were reduced to fiberglass or aluminum facings, and polyurethane foam or resin impregnated paper honeycomb cores. A ten month effort is planned for the development of the ES/C. S.C.W.

N68-27949# Army Engineer Research and Development Labs., Fort Belvoir, Va.

BUILDINGS IN BARRELS, PART 4

S. B. Swenson *In* AFSC Expandable and Modular Struct. Conf. May 1967 p 667–684 refs (See N68-27917 16-32)

Reviewed are new developments and areas of application of the Buildings in Barrels concept which was evolved during an Army sponsored program focusing on the development of: (1) fabrication processes for plastics structures, and (2) the concentration of this research toward systems of on-site fabrication of structures through the utilization of low bulk field expandable materials such as polyurethane foam. The Buildings in Barrels concept makes a system available for field fabrication of aluminum- or plastic-clad polyurethane core buildings, 16 feet or 20 feet wide and any required length, expandable in 4-foot increments. Modules and end walls are fabricated by pouring expandable polyurethane foam materials into mold cavities lined with appropriate facing material and allowing the foam to expand to fill the mold cavity. After a curing cycle ranging from 15 minutes to an hour, the casting can be removed from the mold as a finished structural panel. Two of these panels are connected at the ridge to form a 4-foot module, any number of which, when assembled with the end walls, result in a very efficient structure. The adoption of a mechanical froth foaming technique for mold cavity filling rather than the hand pouring method previously employed, and the development of a structure having a 20-ft. span are cited as being significant improvements. Applications of structures erected in Greenland, in the vicinity of Fort Belvoir, Virginia and Vietnam are discussed. S.C.W.

N68-27989# Naval Research Lab., Washington, D. C. Shock and Vibration Information Center.

THE SHOCK AND VIBRATION BULLETIN, NO. 37, PART 5

Jan. 1968 182 p refs 37th Symp. on Shock and Vibration held in Orlando, Fla., 24–26 Oct. 1967

(AD-668246)

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12. REAL-TIME COMBINED ACOUSTIC-VACUUM TESTING OF SPACECRAFT L. J. Demas (NASA. Goddard Space Flight Center) p 175–182 refs (See N68-28001 16-32)

N68-27995*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

DEVELOPMENT AND VERIFICATION OF THE VIBRATION TEST REQUIREMENTS FOR THE APOLLO COMMAND AND SERVICE MODULES

Dan E. Newbrough (GE, Houston, Tex.), Richard A. Colonna, and James R. West, Jr. (N. Am. Rockwell Corp., Downey, Calif.) *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 89–103 refs (See N68-27989 16-32)

Demonstration of the structural capability of the Apollo command and service modules for withstanding flight environments necessitated extensive vibration test programs, of which a significant part was full-scale command module and service module acoustic tests. Verification of vibration test requirements brought about several interesting problems in flight test simulation. Analyses and manipulations of the acoustic test data resulted in some unique Apollo vibration criteria and procedures. The documentation of these techniques is considered important in the development of manned spacecraft vibration criteria. At Apollo liftoff and during atmospheric flight, the command and service modules are exposed to intense noise which produces high-amplitude structural vibration. The design and test vibration criteria for this environment were derived originally by analytical prediction methods. A brief narrative of the developments leading to the present vibration environment definition for the command and service modules is presented. The basis for the vibration environment initially defined is discussed; the acoustic test programs carried out on the command and service modules are described briefly; the vibration criteria redefinition resulting from the acoustic tests is examined; and data obtained from unmanned Apollo flights are presented. Author

N68-27996# General Electric Co., Houston, Tex.

DEVELOPMENT AND VERIFICATION OF THE APOLLO LUNAR MODULE VIBRATION TEST REQUIREMENTS

Dan E. Newbrough, Murray Bernstein (Grumman Aircraft Eng. Corp.), and Eugene F. Baird (Grumman Aircraft Eng. Corp.) *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 105–115 refs (See N68-27989 16-32)

The Apollo lunar module (LM) size, weight, and configuration have given rise to problems in determining equipment vibration requirements and in verifying structural adequacy for anticipated mission environments. The application of large-scale vibration testing has played a prominent part in qualifying the LM for its intended mission. The LM is subjected to mechanical excitation from on-board engine firings and from acoustic excitation during launch and boost. The LM engine firing conditions were simulated by replacing the ascent stage and descent stage engines with vibration test fixtures and applying shaped random excitation. Simulation of the LM launch and boost vibration environments required use of the unique vibration and acoustic test facility at the Manned Spacecraft Center, Houston, Texas. Testing in this facility resulted in expeditious certification of the LM structure and allowed completion of the necessary equipment qualification testing. The initially predicted LM vibration and acoustic environment is described, and the LM structural vehicle vibration test program is outlined. A brief account of the LM dynamic tests conducted at MSC and the data evaluation are presented. Test results are compared with original predictions, and the effectiveness of the vehicle dynamic test program in certifying the LM for its intended mission is examined. Author

N68-27997*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SATURN S-2, S-4B, AND INSTRUMENT UNIT SUBASSEMBLY AND ASSEMBLY VIBRATION AND ACOUSTIC EVALUATION PROGRAMS

Richard W. Schock, Johnnie M. Everitt, and John R. Seat (Brown Eng. Co.) *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 117–137 refs (See N68-27989 16-32) CSCL 20K

The major factor governing design of rocket-vehicle secondary structure and component parts is the low- and mid-range frequency response of the primary structure shell to acoustic excitation associated with engine and aerodynamic noise. Until recently, laboratory simulation of these imposed acoustic environments has been impossible because of facility size and power limitations. However, recent advances in facility capability have provided means by which full-sized assemblies can be exposed, in ground test, to simulation of vehicle boost vibration and acoustic environments. Marshall Space Flight Center has made extensive use of these capabilities in ground-test developmental programs on S-II, S-IVB, and instrument unit assemblies and subassemblies. Presented are: (a) a summary of these tests; (b) the philosophy of the utilization of assembly tests; (c) methods of establishing test environments; (d) advantages and limitations of this type of testing; (e) a comparison of test results to other types of ground tests and flight environments; and (f) conclusions, derived from these comparisons, on the usefulness and validity of this type of ground test. Author

N68-27998*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

DEVELOPMENT OF ACOUSTIC TEST CONDITIONS FOR APOLLO LUNAR MODULE FLIGHT CERTIFICATION

Wade D. Dorland, Robert J. Wren, and Kenneth McK. Eldred (Wyle Labs., Inc., El Segundo, Calif.) *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 139–152 refs (See N68-27989 16-32)

An acoustic test of an Apollo lunar module test article was performed prior to flight to verify structural and component integrity. Since the lunar module is enclosed within a spacecraft/lunar-module adapter during the first-stage boost when the dynamic pressure environments are encountered, the test was performed in accordance with criteria based on measurements of spacecraft/lunar-module adapter vibration response. The test operations were conducted in the Manned Spacecraft Center Spacecraft Acoustic Laboratory, which employs a progressive-wave mode of acoustic excitation and has a duct system tailored to the outer moldline of the Apollo spacecraft. In the lunar module qualification test, the acoustic spectrum imposed on the spacecraft/lunar-module adapter was nearly as predicted for frequencies above 315 Hz, whereas the low-frequency spectrum contained more energy than predicted. The measured spacecraft/lunar-module adapter responses provided an excellent fit to the flight envelope. Author

N68-27999# General Electric Co., Houston, Tex.

VIBROACOUSTIC TEST METHODS FOR VIBRATION QUALIFICATION OF APOLLO FLIGHT HARDWARE

Richard W. Peverly *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 153–166 refs (See N68-27989 16-32)

Vibroacoustic test methods were used to perform vibration qualification tests on a majority of the components located in the Apollo service module. The test subjects were attached to a structural segment, and realistic reproduction of vibration environments was provided by acoustic excitation. Tests were conducted with both large segments, which simulate a half segment of the Block I and Block II service modules, and small segments, which simulated a radial beam and a fairing. This approach was used to provide a means of duplicating accurately component mounting conditions and thus improving the simulation that would otherwise have been furnished by an electromechanical shaker test. The success of the Apollo tests verified that the concept of vibro-acoustic testing can, in many circumstances, result in a significant improvement in vibration simulation. This paper describes vibro-acoustic tests pertaining to the Apollo program and presents a comparison of vibroacoustic data with flight data and vibration test criteria levels. Also presented is a discussion of some of the advantages and limitations of vibroacoustic testing. Author

N68-28000*# Boeing Co., Huntsville, Ala.

ACOUSTICAL QUALIFICATION OF S-1C FIN STRUCTURES

Clark J. Beck, Jr. and David R. Kennedy (Brown Eng. Co.) *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 167–173 ref (See N68-27989 16-32)

During the launch phase of flight, a spacecraft is subjected to a variety of loads. To establish confidence that a spacecraft will survive the launch environment, practice was to subject a spacecraft and/or components to single environment tests in series, for which specifications included conservatisms in an attempt to cover the unknowns arising from the combination of these single tests. However, a more realistic test philosophy which permits real-time simulation of the combined launch environments has recently been implemented at Goddard Space Flight Center using the launch phase simulator (LPS) test facility. The LPS can reproduce the combined launch environments of vacuum, acoustics, acceleration, and vibration on large spacecraft structures, all in real time. The first combined environmental flight program test performed on the LPS facility is described. This test was the real-time combined acoustic-pressure profile test of the Application Technology Satellite (ATS-A) prototype spacecraft performed on March 16, 1967. The characteristics of the LPS acoustic and vacuum systems, pretest preparation, test philosophy and procedures, and results of the test program are discussed. Also included are a cursory treatment of contamination control of the facility and a brief discussion of other combined environmental tests of this type performed on the LPS. Author

N68-28001*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

REAL-TIME COMBINED ACOUSTIC-VACUUM TESTING OF SPACECRAFT

Louis J. Demas *In* NRL The Shock and Vibration Bull., No. 37, Pt. 5 Jan. 1968 p 175–182 refs (See N68-27989 16-32)
CSCL 20K

Results of acoustic qualification testing on four aerodynamic fins are presented. The fin test specimens were portions of the aerodynamic fins used on the S-IC stage of the Saturn V vehicle. The objective was to determine if the fin could withstand the acoustic qualification test level of 163 db without structural failure. Two fins failed, while the other two fins did not fail under similar test conditions. The difference in test results is attributed to the presence of fiber-glass tape between the skin and ribs of the two fins which did not fail. Strain instrumentation shows a significant reduction in dynamic strain levels because of the presence of fiber-glass tape. The reduction in strain level resulted in the S-IC fin's passing the qualification test. Author

N68-28115*# Techtran Corp., Glen Burnie, Md.

PROPAGATION OF PERTURBATIONS IN A VISCOUS-ELASTIC AND A VISCOUS-PLASTIC ROD [RASPROSTRANENIYE VOZMUSHCHENIY V VYAZKO-UPRUGOM I VYAZKO-PLASTICHESKOM STERZHNE]

I. N. Zverev Washington NASA Jun. 1968 14 p refs Transl. into ENGLISH from Prikl. Mat. i Mekhan. (Moscow), v. 14, 1950 p 295–302
(Contract NASw-1695)
(NASA-TT-F-11722) CFSTI: HC$3.00/MF$0.65 CSCL 20K

The propagation of perturbations in viscous-elastic and viscous-plastic rods is considered. It was shown that deformation velocity is infinite at the start of the shock despite viscosity. The deformation was determined for colliding bodies of various masses for circular cross-section and maximal deformation was found. The viscosity of a rod during a viscous-plastic shock can be found experimentally on the basis of this work. The article is accompanied by figures and tables, and the equations and formulas used in the calculations are also presented. Author

N68-28117# United Kingdom Atomic Energy Authority Springfields (England). Reactor Fuel Element Lab.

HETEROGENEITY IN THE DISLOCATION ASSEMBLY: ITS EFFECT UPON THE PROBABILITY OF FATIGUE FAILURE

J. H. Gittus 15 Jul. 1966 11 p refs
(TRG-1294(S)) CFSTI: HC$3.00/MF$0.65

Use is made of a model of a metal consisting of a statistical assembly of line and point defects to derive an expression for the mean dislocation velocity in terms of stress, temperature, and the frequency of atomic vibration. A diffusion equation that describes the movement, immobilization, and creation of dislocations is developed and solved to produce an expression which relates the mobile dislocation density with its extreme values, strain, and time. The positional dependence of strain in a cracked body under unidirectional or cyclically reversed stress systems is calculated. The behavior near the crack tip is thus related with the macroscopic conditions applied to the body as a whole, and this leads to a fatigue law for failure by crack propagation. Examination of experimental data for fatigue and creep of 20Cr-25Ni-Nb stainless steel and Magnox AL80 provides reasonable justification for the predicted form of stress, strain, frequency, and temperature dependence for mean life. NSA

N68-28140*# Chrysler Corp., New Orleans, La. Space Div.

DUAL ROTARY ACTUATOR, 148,500 INCH-POUNDS, EXCELLO CORPORATION MODEL NUMBER S16X5X6 NASA DRAWING NUMBER 75K26197 Test Report

25 Apr. 1968 55 p
(Contract NAS8-4016)
(NASA-CR-95264; TR-RE-CCSD-FO-1138-3) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Inspection and testing results are reported for a dual hydraulic rotary actuator used to rotate umbilical swing arms from the launch vehicle. During the initial function test the torque produced was within the 148,5000 inch-pounds specified, but this value decreased to a minimum of 132,000 and 134,900 inch-pounds per vane midway through the actuator rotation. The specimen withstood 1000 hydraulic impulse cycles, but the torque in one cell dropped to 105,000 inch-pounds. Static torque developed by each vane in the 5, 25, 20, and 75% of rotation positions was below 148,500 inch-pounds; and breakaway pressure exceeded the specified maximum at 75 psig throughout the testing. Leakage and breakaway discrepancies, however, were not sufficient to adversely affect system operation. M.W.R.

N68-28188# Department of Supply, Melbourne (Australia). Aeronautical Research Labs.

THE USE OF EDDY CURRENT CONDUCTIVITY MEASUREMENTS FOR CHECKING AND PREDICTING THE STRENGTH OF HEAT-TREATED ALUMINUM ALLOYS

J. T. Vietz Nov. 1967 15 p refs
(ARL/MET-51)

The factors affecting the strength and electrical conductivity of heat-treatable aluminum alloys and their relationship to each other are discussed briefly. It is concluded that no unique relationship exists between the two properties; however, some correlation can exist, and, provided considerable information is known about the alloy, an estimate of strength can be made from conductivity measurements. All results and predictions should, however, be carefully considered by a specialist. Hardness tests, although less sensitive, appear to be more reliable in gauging alloy properties. Conductivity measurements and hardness tests together can be useful in identifying heat treatments. As the eddy current method is very sensitive to variations in some of the precipitation phenomena in aluminum alloys, it can be used for assessing the degree of non-uniformity of aging and the extent of local overaging—such as caused by fire—but it cannot be reliably used to detect variations in properties caused by slack quenching. Conductivity measurements on clad material are very questionable since the higher conductivity of the cladding severely affects measurements of core properties. Author

N68-28235# Metaalinstituut TNO, Delft (Netherlands).

INFLUENCE OF PLATE THICKNESS, APPLIED STRESS, AND TEMPERATURE ON BRITTLE FRACTURE BEHAVIOUR IN THE ROBERTSON TEST Progress Report, Oct. 1–Dec. 31, 1967

B. Q. M. Westgeest and H. C. van Elst 16 Jan. 1968 19 p refs
(Contract EURATOM-081-67-1-TEEC (RD))
(EURAEC-1987; EUR-3785) CFSTI: HC$3.00/MF$0.65

The influence of applied stress and plate thickness on the crack arrest temperature in the Robertson test is investigated. Robertson specimens of Super-Elso steelplates of thicknesses 12.9, 20.5, 32.5, 82 and 130 mm were machined from plates with 130 mm thickness. For applied stresses of 20, 30, 50 and 80% of the yield stress the arrest temperature is determined. It was already verified that for the 12.9, 20.5 and 32.5 mm thickness the arrest temperature increases with increasing applied stress and increasing thickness between −40 and +19°C. Author (NSA)

N68-28238*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

USE OF WIRE LACING TO REDUCE BLADE VIBRATION IN AN AXIAL-FLOW COMPRESSOR ROTOR

Roy D. Hager, George W. Lewis, and Jack M. Wagner Washington Jul. 1968 22 p refs
(NASA-TM-X-1603) CFSTI: HC$3.00/MF$0.65 CSCL 20K

The experimental axial-flow compressor rotor had a diameter of 20 inches (50.8 cm), a hub-tip ratio of 0.4, and a blade aspect ratio of 3.6. The rotor was tested with lacing wires installed near the blade leading and trailing edges close to the blade tip. The wires were installed to reduce a severe bending vibration encountered at approximately 45 percent of design speed. Blade vibratory stresses were reduced from approximately ±110,000 psi (±75.902 × 10^7 N/m^2) for the undamped blade to approximately ±1550 psi (±1.070 × 10^7 N/m^2) for the blade with lacing wires. An estimated reduction in the overall rotor efficiency of 1.6 percentage points resulted from the use of the wires. Author

N68-28267# Aeronautical Research Labs., Melbourne (Australia).

A REVIEW OF THE DISCONTINUITY OR HUMP PHENOMENON IN FATIGUE S/N CURVES: THEORIES AND FURTHER RESULTS

J. M. Finney Mar. 1967 45 p refs
(ARL/SM-314) CFSTI: HC$3.00/MF$0.65

The discontinuity or hump phenomenon in fatigue S/N curves has been reported for a wide variety of metals and testing conditions. This review outlines the known factors associated with the phenomenon and suggests that its apparent non-observance until about 1958 is a result of both the relatively small number of specimens used to determine S/N curves, and preconceived ideas as to the shape of such curves. There is evidence that the phenomenon is associated with differences in the mechanism of either fatigue crack initiation or propagation or both at different stress levels. The phenomenon is shown to be particularly important in fatigue life estimation and scatter characteristics of fatigue data. Author

N68-28274# Department of Supply, Melbourne (Australia). Aeronautical Research Labs.

THE PRINCIPLES OF STRUCTURAL GLOBAL VIBRATION TESTS

Gerhard de Vries Oct. 1966 17 p refs Transl. into ENGLISH from La Rech. Aerospatiale (France), no. 108, Sep.–Oct. 1965
(ARL/SM-26) CFSTI: HC$3.00/MF$0.65

Consideration is given to the global method for investigating the vibratory behavior of structures. It is based on the experimental determination of the structural parameters from harmonic vibration tests. Recent developments have made it possible to give to these tests, referred to as global tests, a form adapted to the global method. The term global tests helps to distinguish them from other ground vibration tests which appear in increasing number, and which take various forms according to their particular purpose. Author

N68-28303# Aeronautical Research Labs., Melbourne (Australia).

EXPERIMENTAL PROCEDURES FOR THE GLOBAL VIBRATION TEST OF A STRUCTURE

Christian Beatrix Dec. 1966 21 p refs Transl. into ENGLISH of La Recherche Aerospatiale No. 109 Rept.
(ARL-SM-TRANS-27) CFSTI: HC$3.00/MF$0.65

The global vibration test has been found to be valuable in determining the structural characteristics necessary for the prediction of the aeroelastic behavior of aircraft or missiles. Methods developed during the last 15 years at O.N.E.R.A., previously published separately, are presented collectively in this article. Descriptions and principles of application of these methods are given with the aim of aiding the experimenter. K.W.

N68-28313 Rensselaer Polytechnic Inst., Troy, N. Y.

ON THE BULK-FRICTION AND INTERFACE SHEAR STRESS IN VISCOELASTIC–ELASTIC LAYERED SYSTEM UNDER A MOVING LOAD

Subhash Kumar Batra (Ph.D. Thesis) 1966 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-9274

An investigation is made of the physical behavior of a viscoelastic–elastic layered system under the influence of a moving load. It is restricted to a quasi-static case within the plane strain theory, and the viscoelastic material is represented by a standard linear model in shear. The quasi-stationary nature of the surface deformation and interface shear stress is studied. The surface deformation is correlated with the coefficient of bulk-friction through a newly developed criterion. Dissert. Abstr.

N68-28314 Washington State Univ., Pullman.

LONGITUDINAL ELASTIC WAVE PROPAGATION IN FINITE CYLINDRICAL BARS

Larry Deverne Berthof (Ph.D. Thesis) 1966 144 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-1550

The partial differential equations of motion for three-dimensional dynamic elasticity are derived and simplified for the study of longitudinal waves in cylindrical bars. The conditions for proper behavior at $r=0$ are examined and a stress-free surface is used at $r=R$. The equations of motion and boundary conditions are formulated in terms of deformations and the derivatives are approximated by finite differences. The finite difference equations are integrated for different end conditions with the aid of a digital computer. Stable and accurate numerical solutions are obtained without using the artificial viscosity approximation. The computer program and a detailed explanation are included. The Pochhammer–Chree solution for an infinite bar is traced. The resulting frequency equation is solved numerically for many wave lengths and the radial distributions of the deformations are presented. Dissert. Abstr.

N68-28316 Wisconsin Univ., Madison.

BENDING OF PLATES OF ARBITRARY SHAPES AND WITH MIXED BOUNDARY CONDITIONS

Stanley Shiao-hsiung Chen (Ph.D. Thesis) 1967 90 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-4940

Thin simply connected plates with small deflections are considered. No limitations were imposed on the shapes or boundary conditions. Plates of uniform and of non-uniform thickness were treated. Problems of both static loading and free vibration were investigated for the plates of uniform thickness; only static problems were considered for variable thickness plates. For the plates of uniform thickness, solutions of the differential equation were written in series form and the boundary conditions were satisfied by the method of least square. Six general computer programs, three for static and three for vibration problems, were developed for this case. The programs give the deflection and bending moments in x and y directions at the center under uniform and concentrated loads. The boundary deflection, the slope normal to the boundary and the moment and shear transferred across the boundary were also computed for points along the boundary. Dissert. Abstr.

N68-28323*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ANALYSIS OF THE CRUSHING OF A DOVETAIL PHENOLIC HONEYCOMB SPHERICAL IMPACT LIMITER
A. C. Knoell 1 Jul. 1968 18 p refs
(Contract NAS7-100)
(NASA-CR-95368; JPL-TR-32-1287) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An analysis capability is developed to predict the static and dynamic crushing response of a Dovetail spherical impact limiter. The capability includes (1) a set of design relations to determine maximum limiter impact velocity and deceleration, (2) qualitative expressions to determine the effects of stress waves on limiter dynamic response, and (3) relations to establish the deceleration level at which payload cannonballing, i.e., penetration of the payload sphere into the Dovetail limiter, occurs. Pertinent geometric and material assumptions are presented and the governing differential equation of motion is developed using principles of fluid mechanics. Author

N68-28330*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STUDY OF VIBRATION INDUCED STRESSES IN DESIGN OF FUEL-ELEMENT SUPPORT ASSEMBLY FOR TUNGSTEN WATER-MODERATED NUCLEAR REACTOR
Ivan B. Fiero and Donald W. Adams Washington Jul. 1968 49 p refs
(NASA-TM-X-1608) CFSTI: HC$3.00/MF$0.65 CSCL 18I

The results of vibration tests on a concentric-tube fuel-element support structure for the Tungsten Water-Moderated Reactor are presented. The assembly is a composite material inner tube separated from a concentric aluminum outer tube by springs. The tests show that the assembly must be supported on both ends and at the center of the aluminum tube by the reactor structure. With a cold reactor, only one spring is necessary to ensure that the support tube will withstand lateral vibrational loads. When the reactor is hot, three springs are required. Stress distributions and parameters affecting bending vibration response are discussed. Author

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N68-28986# New York Univ., N. Y.
INTERACTION OF A CHEMICALLY REACTING LAMINAR BOUNDARY LAYER AND AN ABLATING SURFACE. PART 1: ANALYSIS
John Erdos and Adrian Pallone Wright-Patterson AFB, Ohio ARL Feb. 1968 39 p refs
(Contract AF 33(615)-2215)
(ARL-68-0029, Pt. 1; AD-668770)

Laminar flow over the surface of a material that ablates by sublimination is considered. Teflon and Celcon or Delrin are representative of this class of ablators. The coupling between the ablation process and the boundary layer is discussed, and the governing equations and boundary conditions are presented for a multicomponent, reacting mixture of ablated gases and the constituents of air. The multistrip integral method of solving the equations is developed in detail. The results of representative calculations for ablating Teflon cones and Celcon or Delrin cones at hypersonic conditions will also be given later. Author (TAB)

N68-27007# Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
SOME RESEARCH PERTAINING TO THE PROBLEM OF PREDICTING THE BURNING RATE OF CELLULOSIC FUELS
P. L. Blackshear, Jr., K. A. Murty, and J. Matthews 25 Mar. 1968 14 p
(Contracts OCD-OS-62-89; NBS CST-1127)
(TR-5; AD-668531)

The work is divided into two parts. The first part deals with experimental work on the study of the influence of inorganic impurity, specimen size and heating rate on the thermal decomposition of macroscopic cellulosic fuel cylinders. The second part describes an experiment designed and built to study the chemical kinetics of cracking reactions along with the formulation of a comprehensive theory to predict the influence of secondary physico-chemical factors such as properties, convection, diffusion, cracking, etc. on the net burning rate of cellulosic fuels. Author (TAB)

N68-27017# Atomics International, Canoga Park, Calif.
TRANSFUGUE-2A: A DIGITAL CODE FOR TRANSIENT TWO PHASE FLOW IN SINGLE HEATED CHANNELS
J. A. Landoni 15 Mar. 1968 33 p refs
(Contract AT(04-3)-701)
(NAA-SR-12503) CFSTI: HC$3.00/MF$0.65

The TRANSFUGUE-IIa is an improved version of previous codes developed at Atomic International concerning the initiation of boiling in single heated channels, normally cooled by liquid metals. In particular, the present study supersedes the TRANSFUGUE-I code reported in NAA-SR-11008, as well as the succinct description of the TRANSFUGUE-IIa code in NAA-SR-TDR-12485. The main simplifying assumption in these computations is that the homogeneous hydrodynamic model (slipless flow) is obeyed during boiling conditions. In consequence the TRANSFUGUE-IIa code can be considered as a useful code for the computation of, for example, the transient states following a large insertion of reactivity or a sudden decrease in coolant supply pressure. The present code is not in its final form, and it is expected to be improved with more realistic assumption. Author (NSA)

N68-27062# Argonne National Lab., Ill. Reactor Engineering Div.
ON THE SUPERHEATING OF SODIUM AT LOW HEAT FLUXES
Robert E. Holtz and Ralph M. Singer Nov. 1967 33 p refs
(Contract W-31-109-ENG-38)
(ANL-7383) CFSTI: HC$3.00/MF$0.65

Experimental data on the superheat necessary to initiate boiling of sodium were compared to a theoretical nucleation model. The sodium was contained in a vertical pipe and was heated using a high-temperature resistance wire which limited the heat flux to approximately 6 W/cm^2 (19,000 Btu/hr-ft). The system pressure, heat flux, and pressure–temperature history all significantly affected the incipient superheats. The transient pressure was also measured during the sodium nucleation. Although a large scatter in the pressure data was noted, it was concluded that pressure pulses occurred during vapor collapse, even though the liquid sodium was initially superheated. Author (NSA)

N68-27088# Massachusetts Univ., Amherst. Dept. of Chemical Engineering.

DROPWISE CONDENSATION OF STEAM AT ELEVATED PRESSURES

J. B. Dolloff, N. H. Metzger, and L. H. S. Roblee, Jr. 15 May 1968 42 p refs
(Contract Nonr-3357(02))
(ONR-TR-2; AD-668986)

The results of a study of the mechanism of dropwise condensation of steam at elevated pressures are presented. Equivalent heat transfer coefficients for dropwise condensation of steam were determined experimentally for pressures ranging from 0 to 142 psig. The results showed that for each Delta-Ts there is a pressure at which the film coefficient is a maximum and that this maximum increases slightly as Delta-Ts decreases. For a Delta-Ts of 10 and 20 F, the maximum heat transfer coefficient is 33,000 and 24,000 Btu/hr-sq. ft.-F respectively and lies in the pressure range 50-60 psig. It is believed that this maximum reflects the formation of a quasi-film of closely packed drops which offers considerable resistance to heat transfer. Photographic analysis of the dropwise condensation phenomena revealed that the combined effects of drop cycle time, free area available for condensation, and overall temperature driving force are the factors which cause a maximum in the equivalent heat transfer coefficient. A theoretical analysis is presented which is consistent with experimental observations. Also, photographs revealed that dropwise condensation was maintained for pressures up to 120 psig. Author (TAB)

N68-27149# Aix-Marseilles Univ. (France). Inst. de Mechanique Statistique de la Turbulence.

ENTROPY OF A TURBULENT GAS; MACROSCOPIC AND TURBULENT PARTS

A. J. Favre *In its* Final Sci. Rept., No. 4 Jan. 1968 p 1-9 refs (See N68-27148 16-12)

Presented is a discussion on the separation of the entropy for a turbulent gas into a microscopic part and a fluctuation. When the mass-weighted macroscopic part is retained it has the property of evolution corresponding to the second principle of thermodynamics at larger scale of averaging, but it is not in general expressed exactly in terms of mean internal variables in the Gibb's form. When the later form is retained as a definition, it has not exactly in general the evolution property. The defect terms are expressed in both cases for discussion of their values for each field of applications. Author

N68-27176# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMODYNAMICS AND HEAT TRANSFER

A. V. Bolgarskiy, G. A. Mukhachev, and V. K. Shchukin 14 Jul. 1967 609 p refs Transl. into ENGLISH of the book "Termodinamika i Teploperedacha" Moscow, Izd. Vysshaya Shkola, 1964 p 1-492
(FTD-HT-67-182; AD-668264)

Thermodynamics: Parameters of a working medium; Heat capacities of gases; First law of thermodynamics; Basic thermodynamic processes; Second law of thermodynamics; Variation of entropy in processes--entropy diagrams; Real (natural) gases; Cycles of piston engines; Compressor; Cycles of gas-turbine installations; Flow of gases; Basic laws of thermodynamics in application to chemical processes; Equilibrium of thermodynamic systems and dissociation; Combustion processes; Kinetics of chemical reactions. Theory of heat exchange: Heat conductivity under stationary conditions; Heat transfer and methods of its investigation; Heat emission (transfer) during free and forced motion of a liquid (fluid); Heat transfer at high velocity of gas motion; Heat transfer in rarefied gases; Heat transfer during variation in aggregate state and with introduction of extraneous matter into the boundary layer; Radiant heat transfer; Heat transfer; Heat conductivity under unsteady conditions; Heat exchange equipment; Heat shielding (thermal protection). TAB

N68-27215 California Univ., Berkeley.

THERMODYNAMIC PROPERTIES OF NONIDEAL LIQUID MIXTURES

Henry Marcel Renon (Ph.D. Thesis) 1966 251 p
Available from Univ. Microfilms: HC $11.70/MF $3.35 Order No. 67-8636

Representation of excess properties of liquid mixtures is the first topic of this work. Two molecular models are applied and a new equation for the excess Gibbs energy is derived. The first molecular model is constructed for mixtures of simple, nonpolar molecules. The second molecular model applies to alcohol–hydrocarbon solutions. The new equation for representation of excess Gibbs energies of strongly nonideal mixtures is based on Scott's two-liquid model and on an assumption of nonrandomness. It uses compositions in the immediate neighborhood of a molecule, taking into account the nonrandomness of the solution. For the same activity coefficients at infinite dilution, the Gibbs energy of mixing is calculated using the new equation. The new equation contains a nonrandomness parameter α_{12}. Prediction of ternary vapor–liquid and liquid–liquid equilibria from binary data alone is also considered. The second topic concerns an experimental investigation of mixed solvents for extractive process. Experimental data were obtained to evaluate the mixture dimethylsulfoxide-5-nonanone for the separation of n-hexane and hexene-1 by extractive distillation and solvent extraction. Vapor–liquid equilibrium data were obtained. Liquid–liquid equilibrium data were obtained also. Dissert. Abstr.

N68-27219 Michigan Univ., Ann Arbor.

HEAT TRANSFER IN SOLIDIFYING BARS

Andrew Szanto Teller (Ph.D. Thesis) 1966 201 p
Available from Univ. Microfilms: HC $9.25/MF $3.00 Order No. 67-8352

A method for the solution of a two-dimensional Stefan problem is developed. The computations based on this method can predict not only the temperature distribution and the location of the solid–liquid interface but also the shape of the interface. In addition, a versatile horizontal tube furnace has been constructed, which is capable of producing decanted solid–liquid interfaces during normal freezing and zone refining experiments. The problem considered consists of a rectangle containing two different phases of the same material in two regions. The temperature distribution around the rectangle is an arbitrary function of time and and location. The problem is formulated in terms of two simultaneous equations, namely, (a) a differential equation describing the motion of the interface, and (b) a partial differential equation defining the temperature distribution in each of the regions. The finite difference computations were carried out for several possible material constants and parameters. The effects of the heat transfer coefficient, velocity, latent heat and thermal diffusivity on the numerical solution were investigated. The experiments were carried out using indium antimonide. Dissert. Abstr.

N68-27226*# Virginia Polytechnic Inst., Blacksburg. Dept. of Mechanical Engineering.

VACUUM THERMAL CONDUCTIVITY MEASUREMENTS OF NASA E4A1 ELASTOMERIC HEAT SHIELD MATERIAL

R. A. Comparin and W. G. Wilson Jun. 1968 60 p refs
(Contract NAS1-7776)
(NASA-CR-66629) CFSTI: HC$3.00/MF$0.65 CSCL 20M

Vacuum thermal conductivity measurements utilizing the line source technique were made for NASA E4A1 elastomeric heat shield material. Thermal conductivity measurements were made on both vacuum exposed and ambient samples to discern the changes due to vacuum exposure. Measurements were also made on the vacuum samples after reexposure to the atmosphere. The results indicated that vacuum exposure caused about a fifteen percent reduction in thermal conductivity during the 9-day vacuum exposure period. On reexposure to the atmosphere, the thermal conductivity reverted to its preexposure value. Author

N68-27243# IIT Research Inst., Chicago, Ill.
ABLATION AND THERMAL EFFECTS IN A VISCOELASTIC CYLINDER
Warren S. Edelstein Feb. 1968 16 p refs
(Contract N00014-67-A-0210-001)
(TR-2; AD-668623)

The axially symmetric plane strain problem is solved for a hollow viscoelastic cylinder whose outer surface is contained in an elastic casing and whose inner surface is undergoing ablation. Author (TAB)

N68-27252# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIATION OF GAS VOLUMES WITH ARBITRARY DISTRIBUTION OF PARAMETERS [IZLUCHENIYE GAZOVYKH OB'EMOV S PROIZVOL'NYM RASPREDELENIYEM PARAMETROV]
Z. S. Galanova *In its* Herald of Leningrad Univ. Math., Mech., and Astronomy Ser. 23 Jun. 1967 p 87-97 refs (See N68-27244 16-19)

The paper deals with the determination of the radiant heat flow at a given point O from an area in the form of circular truncated cone composed of gases flowing out of a nozzle located at a distance h from a solid wall. The temperature distribution, the internal pressure and the geometric dimensions are assumed to be known. It is accepted that the medium inside this gaseous volume is radiating and absorbing radiant energy, while outside the volume only absorption takes place. For a point lying in the space outside the nozzle below a plane drawn through a section of the nozzle, this problem reduces to an integratable form suitable for programming on a computer. Author

N68-27406*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN EXPERIMENTAL STUDY OF THE DRAG COEFFICIENT OF BURNING ALUMINUM DROPLETS
Roy L. Marshall, Gerald L. Pellett, and Andrew R. Saunders [1966] 19 p refs Presented at 3d ICRPG Combust. Conf., Kennedy Space Center, Fla., 17–21 Oct. 1966
(NASA-TM-X-59145) CFSTI: HC$3.00/MF$0.65 CSCL 21B

The dynamics of 200 to 500 micron aluminum droplets which burn as they fall through stagnant ambient air are examined. The momentum equation for a variable mass is developed to show the effect of combustion upon drag. Efforts were made to characterize the behavior of the particle, its flame zone, and the sequence of events to obtain meaningful values of the drag coefficient and corresponding Reynolds number. High speed motion pictures filmed additional details of droplet appearance and flame structure. Experimental results indicate: (1) As the aluminum droplet burns in ambient air, the particle will puff, spiral, and then fragment. (2) The motion of the droplet relative to the stagnant gas creates a crescent-shaped flame zone. (3) A rapid expansion of the vapor-phase diffusion flame is associated with the primary puff after which the flame disappears. (4) Measurements to calculate the drag coefficient and Reynolds number should be made above the primary puffing event. (5) Calculated values of the drag coefficient and Reynolds number indicate a several-fold increase in the drag coefficient resulting from combustion in air. M.G.J.

N68-27412*# National Bureau of Standards, Washington, D. C. Cryogenics Div.
A BIBLIOGRAPHY OF THERMOPHYSICAL PROPERTIES OF METHANE FROM 0 TO 300°K
L. A. Hall May 1968 120 p refs
(NASA Order R-06-006-046)
(NASA-CR-95219; NBS-TN-367) CFSTI: HC $3.00/MF $0.65 CSCL 20M

References together with an abbreviated abstract are presented for mechanical, thermodynamic, and transport properties of methane from 0 to 300°K published up to December 1967. A total of 660 articles have been indexed. Each article has been reviewed and coded with regard to properties studied, type of article (i.e., experimental, theoretical, etc.), and method of presentation of data. The temperature and pressure ranges for each property under consideration are also given. An index has been prepared according to property with four sub-categories: solid, liquid, gas up to 200°K, and gas above 200°K. Author

N68-27423# Library of Congress, Washington, D. C. Science and Technology Div.
THE CONVECTIVE HEAT TRANSFER BIBLIOGRAPHY Final Report, Feb. 1961–Aug. 1967
Clement R. Brown Wright-Patterson AFB, Ohio AF Mater. Lab. Feb. 1968 82 p
(Air Force Order 33(657)-63-388)
(AFML-TR-68-17; AD-668769)

The Convective Heat Transfer Bibliography is a compilation of 2000 references with abstracts to the monographic, periodical, and report literature issued from 1955 to 1962, on the subject of convective heat transfer and its aerospace applications. The references and abstracts were typed on 5x8 cards. The Bibliography is supplemented by a set of 2000 IBM punched cards, constituting a subject index in considerable depth to the same references, and suitable for retrieving the information in the respective abstracts. The report defines the scope of the task, outlines the bibliographic procedures followed, and describes the end products resulting from the work. Author (TAB)

N68-27440*# Denver Univ., Colo.
SINGLE BUBBLE INITIATION TECHNIQUE BY A LASER BEAM
C. W. Chiang and W. R. Orr [1966] 26 p refs Presented at the Bubble and Drop Phenomena Tech. Sess., Salt Lake City, 21–24 May 1967
(Grant NGR-004-035)
(NASA-CR-81597) CFSTI: HC$3.00/MF$0.65 CSCL 20M

A technique to initiate a single bubble is developed by shooting a laser beam, either on a tiny spherical thermocouple of approximately .012" diameter or on a thin metallic sheet of approximately .002" thickness. The thermocouple is immersed in a pool of boiling water at various subcooled temperature, the thin metallic sheet is a part of the bottom side of the water container. The temperature history of the spherical thermocouple is obtained for different subcooled water temperatures. Pictures at 26,000 frames per second for the initial bubble growth are also obtained. A bubble can be initiated around the thermocouple under various subcooled water temperatures even as high as 40°C. During the initial growth period the sphericity of the bubble is quite good and consistent with other data. Author

N68-27441*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE THERMAL RADIATION CHARACTERISTICS OF SOME HIGH-EMITTANCE COATINGS FOR SPACE APPLICATIONS

B. W. Lewis, W. R. Wade, W. S. Slemp, and D. J. Progar [1966] 16 p refs Presented at the ASM meeting—Session on Coatings, Chicago, 31 Oct.–3 Nov. 1966
(NASA-TM-X-59384) CFSTI: HC$3.00/MF$0.65 CSCL 20M

The results of two investigations of selected factors which may influence the thermal radiation characteristics of high-emittance coatings are presented. One study was to determine the effects of the thickness of ceramic coatings on their high-temperature emittance, and the other study was to investigate the effects of simulated space environments on the emittance of inorganic coatings at moderate temperatures. Four flame-sprayed ceramic coatings of various thicknesses on high-emittance substrate were found to have varying emittance with thickness if the ceramic was semitransparent. A variety of inorganic coatings were evaluated as to their stability of thermal radiation properties to the major space environments. As a result, two excellent candidate coatings for space application were found and characterized. Information as to the types and amount of change due to environmental exposure for these types of coating is presented. Author

N68-27578# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DISPERSION OF A HEATED MASS OF GAS IN REGULAR CONDITIONS [RAZLET PODOGREVAYEMOY MASSY GAZA V REGULYARNOM REZHIME]
I. V. Nemchinov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 27–45 refs (See N68-27575 16-23)

The author investigated the problem of the nonadiabatic flow of a gas with the intensity of energy liberation from the molecules depending on the thermodynamic parameters characterizing the state, such as temperature and density. The analysis for deriving the solutions is analogous to that presented for the problem of adiabatic dispersion of a gas. The equations of energy and momentum are given and the boundary conditions considered. The time dependence of the various parameters is also discussed, and an expression was derived for the pressure at the center at any time. Author

N68-27580# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BURNING STABILITY OF POWDER [OB USTOYCHIVOSTI GORENIYA POROKHA]
A. G. Istratov and V. B. Librovich *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 61–68 refs (See N68-27575 16-23)

The steady-state combustion of powder was investigated and corresponding stability criteria were established. It is assumed that in the combustion model chemical reactions are concentrated in a zone which is negligibly thin in comparison to the region of preheating. The temperature distribution and concentration during combustion are divided into three regions. In region 1 heating starts at T_0 in solid powder and increases to T_s at interface 1–2. Chemical reaction takes place between zones 1 and 2, changing the powder into gas. These gaseous products diffuse through region 2 to the interface of combustion, attain the combustion temperature T_{II}, and undergo the reaction in zone 2–3. Zone 3 represents the combustion products. The heat conduction equations for each zone are written under the assumption that the Lewis number is unity and the heat capacity and the transfer coefficients are constant. A set of eight boundary conditions is given at the powder surface $\xi = 0$ and in the gas, at the reaction zone $\xi = \xi_0$, satisfying temperature continuity flow and mass conservation, and complete consumption of reacting substances. The solution of the heat conduction equation together with the eight boundary conditions generates a set of eight linear, homogeneous algebraic equations for stability criteria. Author

N68-27582# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ONE CASE OF FREE CONVECTION OF A LIQUID IN THE PRESENCE OF DISSOLVING AND ABSORBING WALLS [OB ODNOM SLUCHAYE SVOBODNOY KONVEKTSII ZHIDKOSTI PRI NALICHII RASTVORYAYUSHCHIKHSYA I POGLOSHCHAYUSHCHIKH STENOK]
G. A. Bugayenko *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 87–90 refs (See N68-27575 16-23)

The exact solution is found for the problem of the convection of a liquid enclosed between two vertical coaxial cylinders heated to different temperatures. The outer cylinder (radius R_2, temperature T_1) is soluble so that at its surface the concentration C is that of the saturated solution C^*. The inner cylinder (radius R_1, temperature T_0) absorbs all the diffusing material on its surface so that $C(R_1) = 0$. The coefficients of expansion β_1 and β_2 and of the kinematic viscosity ν are taken at the mean values of T and C, and g is the gravitational potential. The diffusion flux of the dissolved material is given by $J_n = -\rho o D/r \ln(R_2/R_1)[T_1 - T_0) \lambda + C_*]$, where D and λ are the coefficients of diffusion and thermal diffusion respectively (also at the mean values of T and C). Author

N68-27592# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPROXIMATE EQUATION OF STATE OF SOLID BODIES [PRIBLIZHENNOYE URAVNENIYE SOSTOYANIYA TVERDYKH TEL]
V. P. Koryavov *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 195–202 refs (See N68-27575 16-23)

The description of the state of a substance compressed in strong shock waves is considered. For a wide variety of solids it is found experimentally that the velocity of the shock wave D and the velocity of the material behind the front u are related linearly: $D = D_0 + su$. The constant s does not differ much from 1.5, and D_0 is close to the so-called Bridgeman velocity of sound C_B. With several additional assumptions, the complete thermodynamic description for the behavior of a substance with isotropic compression can be obtained. The energy and pressure are seperated into a thermal and a so-called cold part (E_x, p_x), which is connected with deformations of the crystal lattice and is independent of temperature. The relation between the thermal parts is given by the Mie–Grüneisen equation $p - p_x/E - E_x = \gamma\sigma$, where the density σ is in units of the initial density ρ_0, the pressure p is in units of $\pi_0 D^2_0$, the energy E is in units of D^2_0. The solution depends on the form of the Grüneisen coefficient γ. Solutions are indicated for γ—a constant equalling 1 or 2 and for γ—function of $\sigma\gamma = 2(4-\sigma)/(5-\sigma)$. Author

N68-27604# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NONSTATIONARY RADIANT-CONVECTION HEAT EXCHANGE ON RECTANGLE [NESTATSIONARNYY LUCHISTO-KONVEKTIVNYY TEPLOOBMEN NA PRYAMOUGOL'NIKE]
A. L. Burka *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 281–287 refs (See N68-27575 16-23)

We consider the boundary value problem for a right angle region $[0 \leq x \leq L;\ 0 \geq y \geq l]$ with mixed boundary conditions, including convection and radiant fluxes. (Ambient temperature is assumed equal to zero.) Author

N68-27605# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NON STEADY-STATE BURNING OF THIN PLATES OF POWDER [O NESTATSIONARNOM GORENII TONKIKH PLASTIN POROKHA]

Yu. A. Gostintsev and A. D. Margolin *In its* J. of Appl. Mech. and Tech. Phys. 16 May 1967 p 289–292 refs (See N68-27575 16-30)

The equations governing the nonstationary combustion of a plate of powder are solved by the method of integral relations. A formula is obtained for the time of complete combustion of a plate of thickness $2\delta_0$. The combustion was considered to take place along the two unbounded directions parallel to the plane of the plate. The system of equations governing the combustion of the plate is formed where all the quantities are dimensionless.
Author

N68-27637*# Miami Univ., Coral Gables, Fla. Mechanical Engineering Dept.

PRESSURE-DROP OSCILLATIONS IN FORCED CONVECTION FLOW WITH BOILING

A. H. Stenning, T. N. Veziroglu, and G. M. Callahan Mar. 1967 39 p refs Presented at the Symp. on Dyn. of Two-Phase Flow, Eindhoven, Holland, 4–8 Sep. 1967
(Grant NsG-424)
(NASA-CR-83303; Rept.-12) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An experimental and analytical study has been made of oscillations occurring near the onset of boiling in forced convection flow of Freon-11. It has been found experimentally that a finite negative slope in the heater pressure drop characteristic is required to initiate the oscillations. A linearized analysis has been developed which successfully predicts the flow rate at which instability occurs. The major features of the limit cycles have been reproduced by an analog simulation.
Author

N68-27656 Texas A&M Univ., College Station.

A STUDY OF COMBINED HEAT AND MASS TRANSFER BY FREE CONVECTION FROM A CONTROLLED ENVIRONMENT TO A PLATE AT −310°F

Mohammad Rafiqul Bary (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-9773

An experimental study of heat and mass transfer in free convection from a controlled environment to a plate of liquid nitrogen temperature (−310°F) has been made. The total heat transfer rate from the plate was calculated and then the heat transfer rate by convection was computed. Frost surface temperature, mass and thickness data were measured experimentally. Temperature and concentration values inside the boundary layer adjacent to the plate were also measured. Using Newton's Law of convective cooling and Fourier's Law of conductive heat transfer, the values of convective coefficients and frost thermal conductivities were calculated. The energy was transported through the front layer not by simple conduction but by some other mechanisms like internal diffusion of water vapor within the frost layer. The temperature boundary layer profile was in good agreement with a parabolic profile. Average Nusselt, Prandtl and Grashof numbers for heat transfer were calculated from the experimental data for both vertical and horizontal positions of the plate.
Dissert. Abstr.

N68-27663 Purdue Univ., Lafayette, Ind.

THE EFFECTS OF RADIATION ON TEMPERATURE AND HEAT TRANSFER IN LAMINAR BOUNDARY LAYER FLOW OVER A FLAT PLATE

Robert William Crossley (Ph.D. Thesis) 1967 272 p
Available from Univ. Microfilms: HC $12.40/MF $3.50 Order No. 67-10181

An analysis of the effects of interactions among conductive, convective, and radiative transfer on temperatures and heat transfer rates in a boundary layer flow is presented. The flow considered is steady and laminar. The flow is a perfect gas that absorbs and emits diffuse radiation and has a temperature dependant absorption coefficient. The radiation field is one-dimensional. Radiative flux from the ambient fluid to the boundary layer region is formulated in terms of the temperature and temperature gradient at the upper edge of the boundary layer and a single parameter. The presence of significant radiative transfer does not explicitly alter the flow equations which are solved by means of well-known techniques of fluid mechanics. However, the energy equation takes a non-linear partial integro-differential form. The effects of nine parameters on temperature distributions and heat transfer rates at the wall are demonstrated by numerous graphical and numerical examples. The wall emissivity, ε, is found to have small effects on temperature, but significant effects on heat transfer. Changes in wall emissivity influence heat transfer primarily by affecting the total radiative flux leaving the wall.
Dissert. Abstr.

N68-27674 Rhode Island Univ., Kingston.

CONDENSATION FROM SUPERHEATED GAS VAPOR MIXTURES

Frederick Stern (Ph.D. Thesis) 1966 226 p
Available from Univ. Microfilms: HC $10.35/MF $3.00 Order No. 67-5763

The problem of condensation from superheated gas–vapor mixtures was studied on both a theoretical and experimental basis. Superheated mixtures of vapor and non-condensable gas were cooled and condensed in downflow inside a single tube vertical condenser, 0.995 inch I.D. and 3.5 feet long. Cooling water flowed countercurrent to the mixture. Systems studied were air–water, carbon dioxide–water and helium–water. A bulk stream mixing probe was developed which enabled the measurement of point values of the stream temperature and condensable partial pressure at various positions within the condenser. The Reynolds number range of the investigation was 5,700 to 34,000. The theoretical solution of the problem was programmed in the FORTRAN IV language for the I.B.M. 1410 digital computer. The calculation was completely rigorous in computation of both the theoretical partial pressure–temperature path taken by the cooling mixture and the required design length.
Dissert. Abstr.

N68-27697*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TRANSPORT PROPERTIES OF HIGH TEMPERATURE GASES

Richard S. Brokaw Washington 1967 28 p refs Presented at the 3d Intern. Symp. on High Temp. Technol., Pacific Grove, Calif., 17–20 Sep. 1967; sponsored by Stanford Res. Inst.
(NASA-TM-X-52315) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Theoretical tools for estimating high temperature transport properties are discussed, with emphasis placed on the importance of considering the effects due to chemical reactions, multiple interaction curves, and, in partially ionized gases, charge transfer and the long range Coulomb forces. It is pointed out that at high temperatures many gases are partially dissociated and undergo a variety of chemical reactions, and when chemical reaction rates are high, chemical equilibrium can be assumed to exist locally throughout a gas mixture. Experimental studies on nitrogen tetroxide and hydrogen fluoride proved the validity of the theoretical expressions for thermal conductivity of reacting gases in chemical equilibrium. Reduction of heat transport because of reduced reaction rates indicates that heat conduction depends on the geometry and scale of the system and also on the catalytic activity of the surfaces. The interactions between labile atoms or free radicals are usually much stronger than the interactions between valence saturated species, and the transport properties are in turn affected. Examination of the transport properties of ionized gases indicates that accurate calculations require the algebraically complicated Chapman–Enskog approximations.
A.L.

N68-27730 Purdue Univ., Lafayette, Ind.

AN EXPERIMENTAL INVESTIGATION OF THE VELOCITY AND TEMPERATURE PROFILES IN THE BOUNDARY LAYER ABOVE AN UNSTABLE EVAPORATING FILM OF LIQUID UNDER THE INFLUENCE OF A MOVING STREAM OF HOT GAS

Donald Louis Crabtree, Jr. (Ph.D. Thesis) 1967 231 p
Available from Univ. Microfilms: HC $10.60/MF $3.00 Order No. 67-10180

This thesis presents the results of measurements of the velocity and temperature profiles in the boundary layer above an unstable evaporating film of water. Entrained liquid as droplets was present in the boundary layer. The measurements were made at one liquid flow rate. Photographs taken at 3μ sec were obtained of the interfacial structure of the liquid film. The temperature of the film was also measured. The profiles of velocity and temperature in the boundary layer on the wetted wall correlated to power law distributions of 1/7 and 1/6, respectively; the velocity boundary layer on the dry wall correlated to a 1/8.3 power law distribution. The friction coefficient for the wetted wall was determined to be 40 percent greater than for the dry wall. The ratio of the friction coefficient to the Stanton number for the wetted wall was 2.4.
Dissert. Abstr.

N68-27780 Texas A&M Univ., College Station.

RADIATION HEAT TRANSFER FOR STRAIGHT FINS OF TRAPEZOIDAL PROFILE

Robert Doyle Holstead (Ph.D. Thesis) 1967 80 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-9766

The differential equations for steady state and transient heat transfer in straight fins of trapezoidal profile are approximated by explicit finite difference equations. The difference equations are expressed in terms of dimensionless groups, and a computer program for obtaining the solution of the equations is provided. This program is in FORTRAN language. It is demonstrated that the increase of accuracy of a two-dimensional analysis compared to a one-dimensional analysis does not justify the increase in computer time required by the two-dimensional analysis. Guides are also presented for selecting increment sizes for the finite differences. The results of the analyses for several typical fins are presented as plots of the dimensionless groups. Charts for the temperature profile, heat transfer rates, fin effectiveness, and temperature response are shown.
Dissert. Abstr.

N68-27787 Minnesota Univ., Minneapolis.

COMPETITIVE COMBUSTION REACTIONS BETWEEN VARIOUS FLUOROCARBONS BURNING WITH FLUORINE

Jerry Dale Hinderman (Ph.D. Thesis) 1967 156 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-10416

A competition in a fluorine lean environment between the following sets of compounds was investigated: C_2F_6 and C_3F_8, C_2F_6 and c–C_4F_8, and C_3F_8 and c–C_4F_8. The reactions of these compounds were also studied individually and all at the same time in a fluorine lean environment. The reactants were allowed to enter a constant volume vessel and were then subjected to a high voltage spark. The products of the reaction were determined by the use of a Perkin–Elmer gas chromatograph using a silica gel column. It was found that there was a concentration of fluorine in the reactants for which no ignition would occur, and a concentration for which the only product was CF_4 and solid carbon. The first case represented an ignition limit and the second case represented the equilibrium situation. A computer program was devised to calculate the equilibrium constant volume combustion temperature and the composition at this temperature. By observing this temperature at the reactant composition for which the products start to depart from equilibrium, a quasi-ignition temperature may be defined.
Dissert. Abstr.

N68-27834 Pittsburgh Univ., Pa.

THE RESPONSE OF A TUBULAR HEAT EXCHANGER TO LARGE STEP CHANGES IN SPATIALLY UNIFORM SECONDARY CONDITIONS

Samuel Wright Sinderson, Jr. (Ph.D. Thesis) 1966 170 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-9730

Certain optimal control systems require that the manipulated variable be at its extreme value. Thus the study of the response of a tubular heat-exchange system with constant tube-fluid flow rate subjected to large step changes in the spatially uniform secondary temperature is of interest. The investigation had several phases: (a) the experimental measurement of the response of the controlled variable (the outlet tube-fluid temperature) for both single step changes in the secondary conditions and a series of changes; (b) the experimental measurement of heat-transfer coefficients necessary for use in a mechanistic model of the system; (c) the development of a mechanistic model of the system; (d) the development of a model based on the experimentally measured step responses; and (e) the comparison of the experimentally measured multiple-step responses to those calculated using the mechanistic and response models.
Dissert. Abstr.

N68-27846 Washington Univ., Seattle.

HEAT AND MOMENTUM TRANSFER FROM COMPRESSIBLE TURBULENT JETS OF HOT AIR IMPINGING NORMALLY ON A SURFACE

John Frederick Tomich (D.Sc. Thesis) 1967 226 p
Available from Univ. Microfilms: HC $10.35/MF $3.00 Order No. 67-9392

The results of an analytical and experimental study of the heat transfer from the normal impingement of compressible, turbulent jets are presented. A technique for calculating heat flux distributions in the impingement region has been developed, and the calculated results are compared with the measured experimental data. The theory for heat transfer from uniform impinging flows has been adapted to calculate heat fluxes in the stagnation area of an impinging jet, and a solution of the integral momentum boundary layer equation has been used for the calculation of heat fluxes in the remainder of the impingement region. The solution is general enough so that compressible flows with variable wall surface temperatures can be treated. The static pressure distribution and boundary layer thickness in the impingement region have also been calculated. Calculated heat flux and static pressure distributions agree well with the experimental data of the present study.
Dissert. Abstr.

N68-27971# Oklahoma Univ. Research Inst., Norman. Atmospheric Research Lab.

BEHAVIOR OF CONVECTIVE ELEMENTS IN A ROTATING MEDIUM Final Report

Y. Sasaki, E. W. Friday, Jr., and E. M. Wilkins Jan. 1968 125 p refs
(Grant NSF GP-5161)
(ARL-1524-5)

Two experimental studies are described in which the objective was to experimentally and theoretically examine the effect of rotation on the growth of a discrete convective element in the atmosphere. Experimental equipment which was used to study rotational influences on point source convection is described, and procedures for simulating both adiabatic and non-adiabatic thermal convective elements are discussed. A theory is developed which will explain the gross properties of the behavior or convective elements in a rotating medium, and a set of three conservation equations is presented which may be used to describe the thermal growth. Solutions to these equations are shown to be of two basic types: (1) oscillatory solutions which show a suppression of convection by rotation, and (2) exponential solutions which describe enhancements of the convective process. A series of numerical solutions to the conservation equations is discussed in respect to equations that were integrated for the adiabatic and non-adiabatic cases. It is concluded from the theoretical model, that the most important single parameter governing the interaction between buoyant element and a rotating environment is the ratio of entrainment radius to sphere-equivalent radius. B.S.D.

N68-28025# Los Alamos Scientific Lab., N. Mex.

HIGH PERFORMANCE HEAT PIPES

Joseph E. Kemme [1967] 4 p refs Presented at the IEEE Thermionic Conversion Specialist Conf., Palo Alto, Calif., 30 Oct. 1967
(Contract W-7405-ENG-36)
(LA-DC-9027; CONF-671045-4) CFSTI: HC$3.00/MF$0.65

The heat transfer capability of a heat pipe depends to a large extent on the wick structure. Composite wicks are being investigated in heat pipes having several axial channels covered with screen. High heat transfer rates have been obtained with a very fine screen cover and relatively large channels. The fine screen cover provides a large capillary force for fluid circulation. It also suppresses liquid entrainment which might otherwise limit heat transfer. The protected channels provide a low impedance path for liquid return. It is shown that all of these wick functions are important and need to be considered in the design of high performance heat pipes. Author (NSA)

N68-28026# Los Alamos Scientific Lab., N. Mex.

INFLUENCE OF ACCIDENTS IN THE CONTINUING DEVELOPMENT OF CRYOGENIC PROCEDURES

Roy Reider [1967] 17 p refs Presented at the 2d Intern. Cryog. Eng. Conf., Brighton, Engl., 7–10 May 1968
(Contract W-7405-ENG-36)
(LA-DC-9200; CONF-680505-2) CFSTI: HC$3.00/MF$0.65

Several accidents that have occurred from handling, storing, or purging cryogenic fluids are reviewed, and the appropriate safety precautions are briefly outlined. NSA

N68-28100*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN EXPERIMENTAL STUDY OF FLAME PROPAGATION IN SUPERSONIC PREMIXED FLOWS OF HYDROGEN AND AIR

Griffin Y. Anderson and Allen R. Vick Washington Jun. 1968 34 p refs
(NASA-TN-D-4631) CFSTI: HC$3.00/MF$0.65 CSCL 20M

The results of an experimental study of a Mach 1.5 free jet of hydrogen-air mixture ignited by a coaxial, hot gas, pilot jet are presented. This configuration produces an approximately conical average flame surface propagating from the pilot jet into the unburned, supersonic mixture. Flash schlieren, direct, and time schlieren photographic observations of the flame and flow field are discussed for mixtures up to 1.3 times stoichiometric with stagnation temperatures of 300°K and 450°K. Flame cone half-angle measured from time schlieren photographs is found to increase rapidly with equivalence ratio to a maximum at 0.8 times stoichiometric and remain approximately constant thereafter. The maximum flame angle is approximately 9.2° for mixture stagnation temperature of 300°K and decreases to about 7.4° with an increase in temperature to 450°K. Unlike maximum flame angle, the computed velocity normal to the average flame surface or flame-propagation velocity increases with increasing stagnation temperature. Relative values of flame-propagation velocity computed from flame angles measured in supersonic mixtures for hydrogen, methane, ethane, and ethylene were found to be similar to relative laminar burning velocity data for these fuels. Author

N68-28158*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CENTAUR/SURVEYOR NOSE FAIRING AERODYNAMIC HEATING INVESTIGATION

C. W. Eastwood, Jr. Washington Jul. 1968 20 p refs
(NASA-TM-X-1605) CFSTI: HC$3.00/MF$0.65 CSCL 20M

An experimental investigation was conducted to verify the structural integrity of the Centaur/Surveyor fiberglas nose fairing at the thermal and pressure environment predicted for the fourth Atlas/Centaur flight. Specimens of the fairing, including two coated with a protective subliming material, were exposed to the simulated aerodynamic heating and decreasing atmospheric pressure associated with the flight trajectory. Nose fairing specimen skin temperatures, bondline temperatures, and core pressures in the simulated environment are presented. Core pressure required to delaminate the skin-core assembly is given. Fairing skin temperatures from two subsequent Atlas/Centaur flights are compared with the experimental results. Author

N68-28211*# Techtran Corp., Glen Burnie, Md.

EXPERIMENTAL DETERMINATION OF GRAPHITE ABLATION RATES UNDER CONDITIONS OF SUBSTANTIAL NONISOTHERMALITY [EKSPERIMENTAL'NOYE OPREDELENIYE SKOROSTI UNOSA GRAFITA V USLOVIYAKH SUSHCHESTVENNOY NEYIZOTERMICHNOSTI]

A. I. Leont'yev, E. P. Volchkov, Ye. G. Zaulichnyy, and Ye. I. Sinayko Washington NASA Jun. 1968 10 p refs Transl. into ENGLISH from Fiz. Goreniya i Vzryva (SSSR), v. 3, no. 2, 1967 p 248–254
(Contract NASw-1695)
(NASA-TT-F-11738) CFSTI: HC$3.00/MF$0.65 CSCL 20M

Investigated is the ablation of cylindrical hollow graphite samples 170–175 mm long with a wall 10–12 mm thick in an air stream in a graphite channel. A room-temperature air stream is passed for 1–20 minutes at a rate of 3.5–300 m/sec over samples heated to 1700–2100°K. The thickness of sample walls is measured before and after the experiments with a precision comparator. Chemical erosion is found to be basic in the ablation mechanism. A formula is given which describes satisfactorily the experimental results for enthalpy factors from 6.5 to 9.3 and Re_x numbers from 10^4 to 6×10^6. Author

N68-28224# Los Alamos Scientific Lab., N. Mex.

THE PROGRAM QAD 5 FOR CALCULATION OF VOLUME HEATING

J. R. Streetman 15 Apr. 1968 16 p
(Contract W-7405-ENG-36)
(LA-3573, Sup.) CFSTI: HC$3.00/MF$0.65

A FORTRAN program, QAD V, is described, by which heating of a volume of material subjected to gamma radiation from a volume source may be computed. The source volume is represented by an assembly of source points, and a shadow plane behind the volume being heated is tilted with rectangles. Heating along the path from each source point to the center of each rectangle is computed, and a properly weighted sum gives the volume heating. Author (NSA)

N68-28237* Western Co. of North America, Dallas, Tex. Research Div.

TURBULENT HEAT TRANSFER TO VISCOELASTIC FLUIDS

G. T. Pruitt, N. F. Whitsitt, and H. R. Crawford Sep. 1966 40 p refs
(Contract NAS7-369)
(NASA-CR-95261) CFSTI: $3.00 CSCL 20M

An experimental study was undertaken of the turbulent heat transfer characteristics of dilute, viscoelastic distilled water solutions of carboxymethyl cellulose and polyacrylamide. Compared to distilled water, the heat transfer coefficients are reduced, implying a thicker laminar sublayer for these drag reducing solutions. Existing correlations which are used to predict the heat transfer coefficients of Newtonian and purely viscous non-Newtonian fluids do not predict the measured heat transfer coefficients for these friction reducing fluids. However, an empirical correlation is suggested which correlates the data to an average deviation of 7.7% with 73% of the data falling within this limit. Author

N68-28244*# Techtran Corp., Glen Burnie, Md.

GRAPHS FOR THE DETERMINATION OF THE TEMPERATURE FIELD IN TIME IN RODS OR SHEETS OF FINITE LENGTH WITH INTERNAL HEAT LIBERATION [GRAFIKI DLYA OPREDELENIYA TEMPERATURNOGO POLYA VO VREMENI V STERZHNYAKH ILI PLASTINAKH KONECHNOY DLINY S VNUTRENNIM TEPLOOBRAZOVANIYEM]

A. Kessler Washington NASA Jun. 1968 4 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (USSR), v. 7, no. 3, 1964 p 134–136

(NASA-TT-F-11826) CFSTI: HC$3.00/MF$0.65 CSCL 20M

The problem of heating in time in a rod heat insulated on the surface with internal heat liberation and having a constant temperature at one end, is solved. The solution of this problem depends only on the relative position of χ and on the Fourier criterion Fo. The equations necessary for solving this problem are given. Author

N68-28294# Los Alamos Scientific Lab., N. Mex.

TOTAL HEMISPHERICAL EMISSIVITY MEASUREMENTS BY THE HEAT PIPE METHOD

J. E. Deverall 4 Apr. 1968 10 p refs

(Contract W-7405-ENG-36)

(LA-3834-MS) CFSTI: HC$3.00/MF$0.65

The heat pipe appears to have great potential for determining the total hemispherical emissivities of surfaces. If a heat source is located inside a heat pipe, the heat input to the system is accurately known. All of the heat input must be radiated from the external surface of the heat pipe and if the surface is isothermal, the total emissivity can be determined. The heat pipe, with its two-phase fluid flow, has this ability to maintain isothermal conditions over large areas and provides a simple, accurate method for emissivity measurements. By using various heat pipe containers and plating or spraying the containers with different materials, the emissivities of numerous materials can be established. The total emissivities of several different surfaces have been determined over a wide temperature range using a variety of heat pipe sizes and operating fluids. The results indicate that accurate, absolute measurements can be made by this method. Author (NSA)

N68-28324# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Institut fuer Raketentreibstoffe.

CHEMICAL HEATING OF HYDROGEN IN ROCKET COMBUSTION CHAMBERS BY COMBUSTION OF LITHIUMHYDRIDE WITH FLUORINE [CHEMISCHE WASSERSTOFFAUFHEIZUNG IN RAKETENTRIEBWERKEN DURCH VERBRENNUNG VON LITHIUMHYDRID MIT FLUOR]

Roger Edwin Lo Apr. 1968 33 p refs In GERMAN; ENGLISH summary

(DLR-Mitt.-68-09; DVL-723) CFSTI: HC$3.00/MF$0.65

For the three-component rocket propellant combination $F_2/LiH/H_2$ theoretical specific impulse was calculated at expansion from 10 kp/cm^2 to 1 and 0.01 kp/cm^2 and equilibrium and frozen conditions respectively. All mixture ratios between about 10–95% (weight) of F_2, 0–40% LiH and 0–85% H_2 were considered, covering the region of 70–100% of maximum performance. Having a maximum specific impulse of 509 sec. the system $F_2/LiH/H_2$ belongs to the small group of roughly six chemical propellant combinations which surpass the performance of any bipropellant for combinations with stoichiometric ratio of fluorine to lithium theoretical temperatures and compositions of combustion gases are plotted against hydrogen content. Author

N68-28326 Minnesota Univ., Minneapolis.

THERMODYNAMICS OF LOW TENSION AND HIGHLY CURVED INTERFACES

Charles Louis Murphy (Ph.D. Thesis) 1966 263 p

Available from Univ. Microfilms: HC$11.95/MF$3.40 Order No. 67-10454

Interfacial theory, is extended to cover cases previously excluded by Gibbs' basic approximations. Many interfacial phenomena are now known in which low interfacial tension, high interface curvature, and complex fine structure are so important as to negate Gibbs' otherwise successful approximations. Examples occur in spontaneous emulsification and in colloidal systems. The boundary between two bulk phases is treated as a transition zone of finite thickness and significant internal structure. Consequences of interfacial stretching, bending, torsion, chemical reactions, and electric and magnetic fields are included in the interfacial description. In the Introductory Chapter Gibbs' surface-excess scheme is reviewed, and relevant formulas from differential geometry are tabulated. In Chapter B interfacial theory is developed for a static interface. Interfacial stability and critical stability are investigated. In Chapter C the extension to dynamic interfaces is begun; the dynamical state is described by interfacial equations of change of the interfacial mass, momentum, and energy contents. The phenomenon of spontaneous emulsification is reexamined in Chapter D in the light of the newly extended theory. Dissert. Abstr.

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N68-28980*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE INFLUENCE OF FACULTY INVOLVEMENT WITH NASA ON THEIR TEACHING OF AEROSPACE ENGINEERING

Walter T. Olson Washington 1968 24 p Presented at Am. Soc. for Eng. Educ. Ann. Meeting, Los Angeles, 17–20 Jun. 1968

(NASA-TM-X-52461) CFSTI: HC$3.00/MF$0.65 CSCL 05I

Kinds of activity and the interaction that NASA has had with universities are reviewed in an attempt to provide a geneal idea of the part NASA plays in technical activities of universities, and the kinds of influence that faculty involvement with NASA has produced on university teaching of aerospace engineering. It is shown that: (1) although NASA only contributes a modest part of the support required by technical education, the kind of involvement fostered by much of NASA's support appears to have produced valuable results in education, well beyond expectations from the cost; (2) looking at engineering education from the point of view of the user, the most important immediate aspect of this influence has been to acquaint faculty members, the producers, with the kinds of real problems that their students will meet; (3) there is strong evidence in the major contributions made by universities to the Nation's space program, in the quality of engineering graduates, and in the courses and curricula at universities that there has been a cross flow of knowledge and experience in the university community; (5) an important influence has come from the challenge to scientists and engineers to work together on aerospace tasks requiring a multidisciplinary approach; and (6) engineers and scientists that are being trained should be acquiring an increasing awareness of the potential that exists in our growing capability to apply engineering and science massive to and complex undertakings. S.C.W.

N68-27028# Avco-Everett Research Lab., Everett, Mass.
MOLECULAR MIXING LENGTHS FOR TURBULENT WAKES
George W. Sutton Apr. 1968 18 p refs
(Contract F04701-68-C-0036)
(Avco Everett Res. Rept.-286)

A simplified analysis is performed of the turbulent mixing of a trace chemical species with the bulk chemical species. The general relationship between the mixing on a molecular scale and the concentration fluctuation intensity of the trace species is given. This is then applied to a turbulent wake, to determine the axial length that it takes for ingested gas to become mixed. The results are sensitive to the assumed turbulent dissipation rate; giving values of the mixing length from the order of the wake radius to two orders of magnitude larger. Author (TAB)

N68-27069# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
THERMAL CONTROL COATINGS DATA RETRIEVAL SYSTEM, MAY 1966–MAY 1967
Carl P. Boebel Feb. 1968 32 p
(AFML-TR-67-353; AD-669057)

A computerized data retrieval system for thermal control coatings was devised. This general classification system for coatings, while specifically oriented toward optical characteristics for satellite use, can have other applications. The basic use of this system is directed to thermal designers and materials engineers in the aerospace field for data retrieval. This document presents an 'out-of-the-design-loop' assist to the thermal designer for selection of the optimum coatings. It is anticipated that with acceptance and inevitable modifications to this basic system, it can be placed into the thermal design computer program in the near future. Author (TAB)

N68-27429*# Missouri Univ., Columbia. Research Center.
AN ECONOMIC ANALYSIS OF SPATIAL PATTERNS OF RESEARCH AND DEVELOPMENT IN THE PHARMACEUTICAL INDUSTRY
John M. Brazzel 10 Mar. 1967 15 p refs Presented at the Western Regional Sci. Assoc., Las Vegas, Nev., 29 Jan. 1967
(Grant NGR-26-004-012)
(NASA-CR-83283) CFSTI: HC$3.00/MF$0.65 CSCL 05C

The geographic distribution of research activity in the pharmaceutical industry is studied with attention focused on identifying the existing spatial pattern of pharmaceutical research and explaining some of its causes. Based on the simplest hypothesis that research is attracted toward the location of production, the spatial pattern of pharmaceutical R&D is compared with the pattern of production. In order to determine the applicability of this hypothesis, the coefficient of geographic association and the Spearman rank correlation coefficient is used to obtain some measure of the relationship between the spatial patterns of production and research. The coefficient of geographic association is constructed by subtracting each state's percentage share of professional R&D employment from its percentage share of total pharmaceutical employment. It is stated that the most important explanations for the location of pharmaceutical research appears to stem from the nature of the research product and the composition of inputs used for the production pharmaceutical research. B.S.D.

N68-27549*# Texas Univ., Austin.
MEDATA: A NEW CONCEPT IN MEDICAL RECORDS MANAGEMENT
Caroline Horton, Tate M. Minckler, and Lee D. Cady, Jr. [1967] 42 p refs Presented at the Fall Joint Computer Conf., Nov. 1967
(Contract NSR-44-012-039)
(NASA-CR-86715) CFSTI: HC$3.00/MF$0.65 CSCL 05B

MEDATA, an automated medical records system, represents an organized approach to the collection, storage, and retrieval of medical data. This completely user-oriented system takes advantage of the background and training of the medical secretary and simultaneously bypasses the conventional keypunch operators and coders. It is capable of responding directly (in his own terminology) to the user who lacks extensive computer background. The system is inexpensive to maintain, and the programs and basic system concepts are machine independent. Author

N68-27724* Wayne State Univ., Detroit, Mich. Center for Application of Science and Technology.
DISSEMINATION OF AEROSPACE SCIENCE AND TECHNOLOGY TO HIGHWAY SAFETY AND HIGHWAY TRANSPORTATION PROGRAMS Final Report, 1 Jan.–1 Apr. 1968
Hamilton Stillwell Apr. 1968 92 p refs
(Contract NSR-23-006-041)
(NASA-CR-95223) CFSTI: $3.00 CSCL 05B

The application of NASA literature to highway safety and transportation engineering was found to be feasible. NASA generates considerable data in biomechanics, restraint systems, psychology, human engineering, human transfer functions, probability, queueing theory, etc. They also provide engineering data on mechanical and electronic equipment that can be utilized in monitoring operator or vehicular motions. The group studying police vehicles will make use of the human engineering ideas presented by NASA research and may suggest the implementation of NASA hardware designs in future vehicles. Author

N68-27742# Congress. House. Committee of Science and Astronautics.
SUPPORT SERVICE CONTRACTING BY THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington GPO 18 Apr. 1968 51 p Staff Report for the Subcommittee on NASA Oversight of the Comm. on Sci. and Astronautics 90th Congr., 2d Sess.

Support service contracting by NASA is summarized, and a listing is included of all contracts of $100,000 and over for fiscal 1968. This staff report of the House committee on Science and Astronautics gives the NASA policy regarding the use of support services contracts, the chronology of major events and major NASA actions since the June 1967 hearings, and the potential impacts of the opinion of the general counsel of the Civil Service Commission with regard to NASA mode of operations. Forms reproduced include a Summary of Contractor and NASA Performance Costs, Worksheet for Contractor Performance Costs, and Worksheet for In-House Performance Costs; and explanations for each form are attached. Also appended is a revision of Bureau of the Budget Circular A-76 that deals with the basic policies to be applied by executive agencies in determining whether commercial and industrial products and services required by the Government are to be applied by the Government itself or private contractors. M.W.R.

N68-27743# Congress. House. Committee on Science and Astronautics.
A NATIONAL PROGRAM OF INSTITUTIONAL GRANTS FOR SCIENCE AND SCIENCE EDUCATION
Washington GPO 1968 136 p refs A Study for the Subcommittee on Sci. Res. and Develop. of the Comm. on Sci. and Astronautics Prepared by Library of Congress

Background information is provided on the legislative precedents of the national institutional grants program being proposed by H.R. 875 for science research and science education. The Federal role in academic science support is discussed, as is the pending legislation and its comparison with other pending bills. Federal support of institutional science programs for direct aid to institutions of higher learning is considered in terms of programs of the National Science Foundation; Department of Health, Education, and Welfare; Department of Defense; and NASA. Major Federal programs intended to provide direct aid for development of academic institutions are tabulated; as are uses of institutional grant funds, university science development awards, and NIH and Office of Education funding of institutional development programs. M.W.R.

N68-27744# Congress. House. Committee on Science and Astronautics.

MANAGING THE ENVIRONMENT

Washington GPO 1968 59 p refs Report of the Subcommittee on Sci. Res. and Develop. to the Comm. on Sci. and Astronautics

Recent findings on overall environmental quality and public policy are summarized in this report of a subcommittee of the House Committee on Science and Astronautics which is carrying on a continuous program that deals with technological, economic, social, institutional, legal, and political problems that are part of environment management. Recommendations relate to national policy for environmental management, the relationship of science and technology to the environment, and organization for environmental engineering management. A sequence of events in environmental quality issues, relationship of man and his environment, bases for policy, and organizational needs are reviewed along with information and coordination needs. M.W.R.

N68-27912*# California Univ., Berkeley. Space Sciences Lab.

A CRITIQUE ON THE APPLICATION OF SYSTEMS ANALYSIS TO SOCIAL PROBLEMS

Ida R. Hoos May 1967 28 p Presented at the 13th AAS Ann. Meeting, Dallas, 1–3 May 1967 *Its* Internal Working Paper 81
(Grant NSG-243-62)
(NASA-CR-85204) CFSTI: HC$3.00/MF$0.65 CSCL 05K

Systems analysis related to technology utilization and spinoff from aerospace research is discussed, along with resultant knowledge on problems created by science and technology, and the social and political environment in which such problems exist. The reasons for, and the processes by which public agencies utilize aerospace experts are treated on the basis of systematic analysis by engineers from four large corporate facilities in California. Government–industry interaction and its professional and bureaucratic aspects are considered, as are the implications of information technology. Systems techniques are concluded to be useful in new areas for the discovery of the basically multi-faceted nature of every major problem facing the government planner; and systems analysis may result in being both the vehicle to and the end product of creative synthesis of results from efforts in many disciplines to understand the problems facing society. M.W.R.

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